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The publications of the National Museum consist of two series: Proceedings and Bulletins.

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S. P. LANGLEY,
Secretary of the Smithsonian Institution.



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A TREATISE ON THE ACARINA, OR MITES.

By NATHAN BANKS,
Custodian of Arachnida.

PREFACE.

The mites have always attracted considerable interest, both from their minute size and because of the remarkable habits of many species. Although many have examined them in a desultory way, but few have really studied them. Consequently there is a great amount of literature by many persons, much of which is not reliable. Too often entomologists have considered that their knowledge of insects in general was a sufficient basis for the description of mites. Probably the lack of general works on mites has been responsible for many errors. For years the only work treating of the mites as a whole that has been accessible to American naturalists is Andrew Murray's *Economic Entomology; Aptera*. In this book, nearly 300 pages are devoted to Acarina. Unfortunately Murray's treatment is far from satisfactory and abundantly stored with mistakes, many, however, taken from other writers.

Since that book was published several European specialists have been at work on the European fauna and produced monographs which are of great accuracy. Not only have many new facts been discovered, but many of the old facts have been given quite new interpretations. Such a belief as the parasitism of the *Uropoda* on the Colorado potato-beetle seems hardly as yet to have been eradicated. To present a reliable text to the American reader is my intention. Very frequently I have obtained many facts of importance and interest from the European literature; particularly is this true with those parasitic groups with which I am not so well acquainted. Errors will, of course, be found, but great care has been exercised in choosing the sources of information.

I have given tables to all the known American genera, and in some families added other well-known genera which will doubtless occur in our fauna when it is more thoroughly explored.

Practically the only door through which one may enter into the systematic study of mites in general is Canestrini's *Prospetto dell'Acarofauna Italiana*.

INTRODUCTION.

The Acarians form an order in the great class Arachnida. They are thus related to spiders, daddy-long-legs, and scorpions. A few writers at various times have claimed that the mites were a separate class, but the best sense of modern authors is that they are genuine Arachnids, and in many ways closely related to Solpugids and Phalangids. Although quite easily recognized at sight, it is not so easy to give definite characters whereby to distinguish a mite from other Arachnids. The abdomen and cephalothorax are broadly united to each other, and often there is no distinction between these parts. Usually there is no trace of segmentation, but in some forms it is quite distinct. Eyes are often present, but rarely only a median pair as we

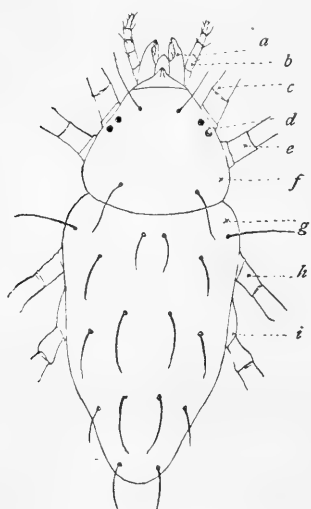


FIG. 1.—DORSAL VIEW OF A MITE. *a*, MANDIBLES; *b*, PALPI; *c*, LEG I; *d*, EYES; *e*, LEG II; *f*, CEPHALOTHORAX; *g*, ABDOMEN; *h*, LEG III; *i*, LEG IV.

find in Phalangids and Solpugids. The mouth segments have become united to form a beak, rostrum, or capitulum. However this is not easily made out in some forms. Commonly the larva at birth has but three pairs of legs, and obtains the fourth pair only after a molt and metamorphosis. In the Eriophyidae, however, there are but two pairs of legs in both adult and young, and in *Pteroptus* the young have eight legs at birth. The adult mite has (except in the Eriophyidae) four pairs of legs; often arranged in two groups, the hinder pairs apparently arising from the abdomen. However it is not probable that such is the case; rather the coalescence of the abdomen and cephalothorax has effaced the true outlines of these portions. It is probable that the abdomen of mites is more than the abdomen of other

Arachnids. If one examines a *Solpuga*, he sees that the cephalothorax is divided into several portions, and it may be that the cephalothorax of mites represents only the anterior of these, while the abdomen of mites represents the abdomen of *Solpuga* plus the two posterior divisions of the cephalothorax. In *Tarsonemus*, and some other genera, the abdomen shows on the dorsum distinct traces of segmentation. On the venter there is still less distinction between parts, and in several groups, as Ixodidae and some Gamasidae, the genital segment is pushed forward between the legs so far that the genital aperture is close to the mouth. In other forms the genital opening is at the extreme tip of the body, and the anus is upon the dorsum.

The cephalothorax, or anterior part of the body, commonly has one or more pairs of simple ocelli-like eyes. They are usually sessile, but sometimes elevated on pedicels.

The mouth-segments form typically a truncate cone or beak. Sometimes it is partially or completely retracted into the body. The mouth parts are the mandibles and palpi. Frequently there are other parts, as a hypopharynx, a lip, or definitely separated maxillæ, as will be mentioned under each family. Several investigators have claimed that there are three or four mouth appendages, and there are structures in some forms that indicate three. The mandibles generally are of two joints. The last is often opposable to a projection of the preceding, so as to become chelate. However, in many forms the mandibles are slender, needle-like, and suited for piercing. In each of the three large families (Oribatidæ, Gamasidæ, and Tyroglyphidæ) which typically have chelate mandibles there is one genus with styliform piercing mandibles. The palpi have never more than five joints; the last is frequently provided with peculiar sensory hairs. In some cases the palpi have a geniculate attitude. The various forms of palpi may be grouped into four classes. (1) Where they are simple, filiform, and have a tactile function; (2) where they are modified for predatory purposes, being provided with spines, hooks, or claws; (3) where the last joint is opposable to the preceding, so that the mite may by its palpi cling to some object; (4) where they have become obsolete, and are more or less united to the rostrum. The basal joints of the palpi are at times differentiated to form maxillæ.

In several families there is a distinct lingula, tongue, or hypostome, which arises from the inner base of the beak, and may be divided or simple. It may have a groove above, called the vomer. The hypostome is usually not visible except by dissection, but in the ticks it is very large and roughened with sharp teeth.

Sometimes the basal joints of the palpi unite to form a lip, or labium. Above the mandibles in many forms is a thin corneous plate, known as the epistoma. Its sides may be partly united to the beak or lip below and thus form a tube, called the oral tube, for it is through it that the mandibles are protruded.

The pharynx, or sucking portion of the alimentary tract, is sometimes prolonged forward into a sort of cone between the mouth-parts.

The opening of the body into which the mouth-parts are inserted is known as the camerostome. In one group (*Uropoda*) the anterior legs are also inserted into this camerostome.

The adult mite generally has four pairs of legs, and the larva three pairs. It has been shown that the embryo of certain forms (*Gamasus* and *Ixodes*) has four pairs of legs before birth, but one pair is aborted to be again developed at the nymphal stage. This is an indication that the six-legged larva is a secondary development, and lessens the

apparent difference between Acarina and other Arachnida. The legs are composed of from five to seven segments; in some forms the apical joints are subdivided, but do not form genuine segments. The length and character of the joints vary in the different families, but usually there are distinguishable the following parts: coxa, trochanter, femur, patella, tibia, and tarsus. In some cases the femora are divided into two parts. The legs are provided with hairs and spines, sometimes modified for some particular function. In several groups there are organs on the anterior legs which appear to have an auditory function. The last joint or tarsus is commonly terminated by from one to three claws or unguis. In some groups there is a difference in this respect between the young and the adult. The claws are not often toothed. In many cases there is a median cup-shaped sucker, pulvillus, caruncle, or ambulacrum between the claws or bearing them.

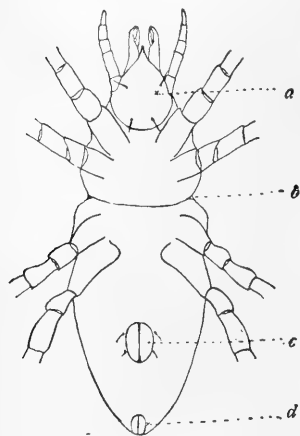


FIG. 2.—VENTRAL VIEW OF A MITE.
a, BEAK; b, TRANSVERSE FURROW;
c, GENITAL APERTURE; d, ANAL
APERTURE.

The reproductive organs, as in other Arachnids, open on the ventral surface of the abdomen near the base. The female aperture (vulva or epigynum) is of various shapes, and sometimes closed by flaps or folding-doors. The male aperture (epiantrum) is usually smaller than that of the female. The body is often provided with hairs, bristles, or scales, which are of characteristic nature and arrangement in each species.

In many of the soft-bodied forms there are chitinous plates, scutæ, or shields, sometimes so large or so numerous as to almost completely cover the mite. These shields are often sculptured or pitted in a characteristic manner. Frequently there are secondary sexual differences both of color and structure, as will be noticed under each family. The male is often a little smaller than the female, but in many cases there is no apparent difference in size.

The internal anatomy of mites is marked by great centralization of parts, the various organs being much more crowded together than with other Arachnids. The alimentary canal, when fully developed, consists of the pharynx or sucking-organ; the œsophagus; the stomach or ventriculus, with its cœca; the hind gut or intestine, and the Malpighian vessels which enter the latter near the rectum.

The pharynx is a partially chitinous tube, convex below, concave above; to its upper part or roof are attached the muscles, which, upon contracting, elevate the roof. A series of muscles, each moving just after the one in front, produces a steady flow of food to the stomach.

The œsophagus is a long simple tube; the stomach is of varied size and shape, according to the food-habits. Sometimes there is an enlargement of the œsophagus near its end, thus forming an ingluvies or crop. In some forms the cœca are extremely long or numerous. The Malpighian vessels, when present, are two in number, and enter the short intestine near its end. The latter is sometimes provided with an enlargement, the colon. In many mites the digestive system is much simplified. In many, if not all, of the forms allied to *Trombidium*, and the water-mites, there is no certain connection between the stomach or ventriculus and the anus. The ventriculus ends blindly; the anus opens into a large tube, supposed to have an excretory function. Many of these forms feed on animal juices, so probably have no excreta.

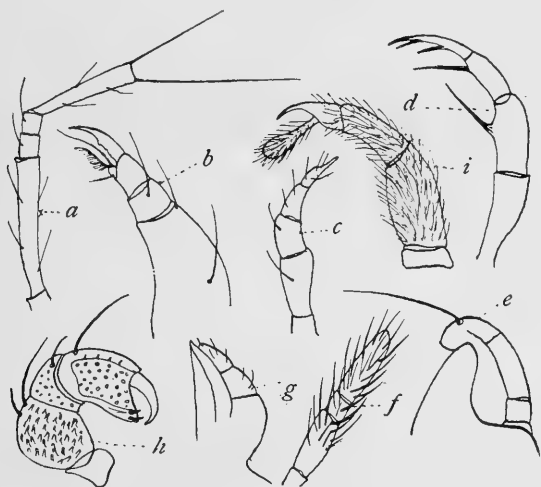


FIG. 3.—PALPI OF VARIOUS FORMS. *a*, *BDELLA*; *b*, *CHEYLETUS*; *c*, *GAMASUS*; *d*, *SCIRUS*; *e*, *HISTIOSTOMA*; *f*, *EUPODES*; *g*, *SARCOPTES*; *h*, *ARRENUUS*; *i*, *TROMBIDIUM*.

The nerve ganglia are united into one mass of considerable size, pierced by a hole for the œsophagus. This brain doubtless is formed of the supra and sub-œsophageal ganglia and their commissures, but so closely are the parts united that all trace of demarcation is commonly lost. The principal nerves arise from this brain. There is one unpaired nerve, and nine or more pairs of nerves. Three sets of paired nerves and the unpaired one arise from the supra-œsophageal ganglion and are of small size. The other six or more sets of paired nerves arise from the sub-œsophageal ganglion and are mostly of larger size. The unpaired, or medium nerve, goes to the pharynx. The paired nerves of the supra-œsophageal ganglion go to the eyes, the mandibles, and the large vertical muscles near the base of the rostrum. Of the nerves of the sub-œsophageal ganglion, one pair goes to the palpi, four to the legs, and one to the genital and other abdomi-

nal. organs. Sometimes there are other nerves that extend to the posterior part of the body.

The reproductive system is often highly developed, and frequently occupies a considerable part of the body. The male testes are large, lobate, and open into two tubes, the *vasa deferentia*, which, uniting, form the *ductus ejaculatorius*, which may open through a penis. The testes are often united. The ovaries of the female (sometimes united) are situate in the middle part of the body, of varying shape, and open into two tubes—the oviducts—which unite to form the vulva. The latter may have a spermatheca attached, and may open through an extensible ovipositor. In some families the vulva is not a *bursa copulatrix*, but there is a special copulatory opening near the anus. In other forms the female organs are very different, as will be mentioned under the families.

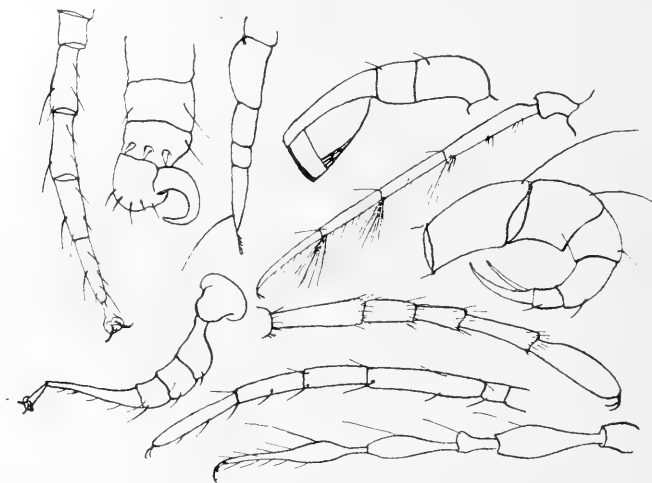


FIG. 4.—LEGS OF VARIOUS MITES.

In the Gamasidæ, Tyroglyphidæ, and Oribatidæ there are a pair of glands in each side of the abdomen, each opening by a pore in the skin. They contain a yellowish, oily liquid, and are considered excretory glands; Michael has called them *expulsory vesicles*. In most mites there are several glands in the head region, some of them evidently of a salivary nature, but others are often present whose function is unknown. Some of them open into the mouth, or pharynx, and others may open at the base of the mandibles.

In some mites there is a well-developed dorsal pulsating organ or heart, but in most mites it is not present. In these latter there is an irregular motion of the body-fluids kept up by the action of the muscles in other movements. Many mites have an elaborate tracheal system for breathing. These tracheæ open in various parts of the

body; in many common forms they open near the mandibles. In ticks and Gamasids they open near the hind legs. In other forms they open in the acetabula or coxal cavities. The openings of the tracheæ are through stigmata or spiracles which vary in different forms. Commonly there are one or two main tracheal trunks in each side of the body, each giving off many branches. In some forms there is a short tracheal trunk which at its tip gives rise to a great number of fine long tracheæ, each of which is unbranched. A great many mites, however, have no internal respiratory system whatever. In these forms the skin is soft, and they absorb oxygen by osmosis through the general surface of the body.

The muscular system of mites varies greatly in the different genera. Strong muscles are attached to the mandibles for extending and moving these organs. Still more powerful ones are attached to the legs, and those for the pharynx and organs of generation are often promi-

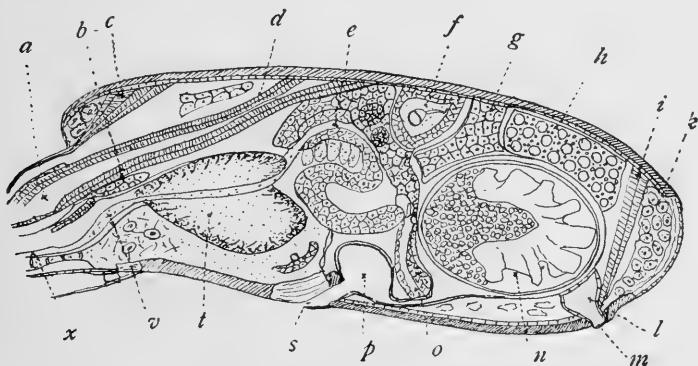


FIG. 5.—ANATOMY OF GAMASUS. *a*, MANDIBLE; *b*, SALIVARY GLAND; *c*, RETRACTOR ROSTRUM; *d*, MUSCLES OF MANDIBLES; *e*, VENTRICULUS; *f*, SACCULUS FOEMINEUS; *g*, LYRATE ORGAN; *h*, OVA; *i*, LEVATOR ANI; *k*, FAT CELLS; *l*, CLOACA; *m*, ANUS; *n*, EMBRYO; *o*, HIND GUT; *p*, VAGINA; *s*, VULVA; *t*, BRAIN; *v*, OESOPHAGUS; *x*, PHARYNX.

nent. There are also muscles connecting various parts of the integument and in some cases one or two pairs attached near the middle of the dorsum. These latter often produce the depressions in the dorsal surface which are commonly found in many of the soft-bodied mites.

The life histories of mites are extremely variable, and will be described under each family. There are typically four stages—egg, larva, nymph, and adult. Many mites, however, have developed a complicated arrangement of forms that almost obscures this fundamental simplicity. Most of these additional phases occur during the nymphal stage, the growing stage of the acarian.

Nearly all mites deposit eggs, but there are a few forms known to be viviparous, or at least ovoviviparous, and one, *Pediculoides*, brings forth adult males and females.

The general plan of development is as follows: The egg is usually

deposited by the female. Often within this egg, while the embryo is developing, an inner membrane is formed which incloses the young mite; this stage is the "deutovum." The outer shell may be cracked so as to show this membrane, or it may be wholly discarded. The larva at birth has but six legs. It feeds for awhile, then passes into a resting stage which in time discloses the eight-legged nymph. The added pair of legs is the fourth, at least usually. During the nymphal period the mite may molt one or more times and change its appearance, but is always destitute of true genital orifices. At the end of the nymphal stage it passes again into a quiescent condition, and in due time molts into the adult mite. During these resting stages much of the internal anatomy of the mite may undergo histolysis, each new stage being rebuilt from the disintegrated tissues of the preceding stage. The genital organs are, however, not affected by these histolytic processes.

The common impression that most mites are parasitic is entirely erroneous. About half of the known species are not parasitic in any stage, and many which are found attached to insects and other animals are not true parasites thereon. Most mites ordinarily move quite slowly, but when disturbed some can travel at an astonishing pace. A very few species are fitted for leaping. Aquatic mites occur in both fresh and sea water. Ticks occur on mammals, birds, and even on snakes and turtles. The bird-mites live on the feathers and skin of birds; the itch-mites burrow within the skin of man and other mammals. Other species live in the cellular tissue of birds; a few occur in the tracheal passages of seals, and one has been found living within the lungs of a monkey. Many species feed on living plants, and the gall-mites produce curious deformations on leaves and twigs.

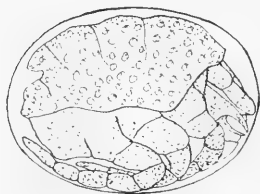


FIG. 6.—EMBRYO OF GAMASUS.

Mites are distributed throughout the globe, but appear to be most numerous in temperate regions. Many are abundant in high latitudes. Single species are sometimes widely distributed; however, as a whole, mites are subject to the usual rules of geographic limitation. Most of the parasitic forms follow the distribution of the host. A few of the free mites are common in widely separated regions, but many, especially the myrmecophilous ones, are very local. Most of the free-living species and those parasitic on plants spread by their own wanderings, but many have developed, for the purpose of migration, a peculiar nymphal form (the *Hypopus*), which clings to other animals that will visit places similar to the mite's birthplace. Most mites are not readily destroyed by cold or moisture, and through this hardiness can extend their distribution.

Most mites have but few enemies outside of their predatory relatives.

There are, however, various cases of protective resemblance, especially among the immature forms. No examples of mimicry, I think, are known.

A great many mites are more or less injurious to the property of man. Three, at least, can be ranked as pests of great importance, namely, the cattle-tick, the sheep-scab, and the pear-leaf blister-mite. The classification of mites has in recent years been developed to a considerable degree. The group is usually held to be an order, including about thirty natural groups. An excellent historical review of the classification of Acarians has been presented by Trouessart.^a The value of these natural groups of mites has been variously estimated by different authors as tribes, subfamilies, and families. Kramer in 1877 originated an ingenious scheme, which has been extended by Canestrini, whereby the mites are arranged according to the position of the opening of the tracheal system. By this method there are six main divisions of the Acarina.

Canestrini's classification is as follows:

ASTIGMATA—Vermiformia and Sarcoptina.

HYDRACARINA—Water mites.

PROSTIGMATA—The Trombidoidea and Eupodoidea of this paper.

CRYPTOSTIGMATA—The Oribatid mites.

METASTIGMATA—The ticks.

MESOSTIGMATA—The Gamasoidea of this paper.

Trouessart has modified this scheme somewhat. He divides the mites into two orders, Acarina and Vermiformia; the latter group again into Octopoda (Demodicidæ) and Tetrapoda (Eriophyidæ). The true Acarina he divides into three suborders, the Prostigmata (including the Hydracarina of Canestrini), the Metastigmata (including the Mesostigmata and Cryptostigmata of Canestrini), and the Astigmata (including only the Sarcoptina). In the writer's opinion the Oribatidæ and Tyroglyphidæ are more closely related than indicated in either of these classifications.

In the arrangement used below, the main divisions are about the same, although based largely on other characters. These characters will be found defined under the various families; and although there are exceptions to the tables they are not prominent, and to have provided for them would heavily incumber the synopses. The characters used in defining genera and higher groups vary greatly according to the group. In some cases genera are based on very minute structures, which in other families are of no value. In several groups the habitat is the best clue to the systematic position. About three hundred and fifty species are known from this country, where there are doubtless a thousand or more, so that the student must not be surprised to

^a Revue des Sciences naturelles de l'Ouest, 1891, pp. 289-308; 1892, pp. 21-56.

find forms that do not fit into tables. Several of the families are not natural, and future study will greatly modify existing systems.

I have not made many new genera in the American mites. I believe in keeping genera as broad as possible. Division of a genus should be made only on grounds of convenience or those of zoological necessity. Because a group of species in a genus differs from the other forms by some structural character, there is not, I think, sufficient reason for a new genus. But whenever a species or group of species differs from the others by several disassociated points of structure, together with differences in life history or habits, then a new genus is advisable. However, in using an adopted classification it is sometimes not easy to place a new form without either making a new genus or modifying the characters of existing genera. The history of Acarology warrants the student in using much caution in the creation of new genera or higher groups.

In regard to nomenclature, I have not departed, save in a few cases, from that in common acceptance among acarologists. In some families there has been much difference of opinion, and lately Doctor Oudemans, an able Dutch acarologist, has revised the nomenclature. It is difficult to escape some of these changes, but others I can not accept, nor go back of 1758 for generic names. The larger groups I have called superfamilies, in accordance with the custom of the best zoologists, and these divisions are practically the same as I used in 1895.

To the ordinary person mites do not exist. Occasionally he may have painful evidence of their presence, but he has no idea of the number of specimens and species around him. Yet a little careful searching will reveal a world of these tiny creatures. Although Müller early described many water-mites and Hermann (1804) and von Heyden (1816) had gathered a few, yet this world of mites was practically unknown until discovered by C. L. Koch about 1840. Since then a number of naturalists have partially explored its shores, and sometimes penetrated into the interior. Now there are about a dozen persons who seriously study acarology and nearly as many more who devote themselves to the water-mites.

SYNOPSIS OF SUPERFAMILIES.

1. Abdomen annulate, prolonged behind; very minute forms; often with but four legs.....DEMODICOIDEA
Abdomen not annulate nor prolonged behind; always with eight legs2
2. With a distinct spiracle upon a stigmal plate on each side of body (usually below) above the third or fourth coxae or a little behind; palpi free; skin often coriaceous or leathery; tarsi often with a sucker3
No such distinct spiracle in a stigmal plate on this part of body.....4
3. Hypostome large, furnished below with many recurved teeth; venter with furrows; skin leathery; large forms, usually parasitic.....IXODOIDEA
Hypostome small, without teeth; venter without furrows; body often with coriaceous shields, posterior margin never crenulate; no eyesGAMASOIDEA

4. Body usually coriaceous, with few hairs; with a specialized seta arising from a pore near each posterior corner of the cephalothorax; no eyes; mouth-parts and palpi very small; ventral openings of abdomen large; never parasitic; tarsi never with a sucker ORIBATOIDEA
Body softer, without such specialized seta 5
5. Living in water HYDRACHNOIDEA
Not living in water 6
6. Palpi small, three-jointed, adhering for some distance to the lip; ventral suckers at genital opening or near anal opening usually present; no eyes; tarsi often end in suckers; beneath the skin on the venter are seen rod-like epimera that support the legs; body often entire; adult frequently parasitic.
SARCOPTOIDEA
Palpi usually of four or five joints, free; rarely with ventral suckers near genital or anal openings; eyes often present; tarsi never end in suckers; body usually divided into cephalothorax and abdomen; rod-like epimera rarely visible; adults rarely parasitic 7
7. Last joint of palpi never forms a "thumb" to the preceding joint; palpi simple, or rarely formed to hold prey; body with but few hairs. EUPODOIDEA
Last joint of palpi forms a thumb to the preceding, which ends in a claw (a few exceptions); body often with many hairs TROMBIDOIDEA

SYNOPSIS OF FAMILIES.

DEMODICOIDEA.

- With but four legs, of five joints each; living on plants, often in galls. ERIOPHYID.E
With eight legs, of three joints each; living in skin of mammals. DEMODICID.E

SARCOPTOIDEA.

1. With tracheæ; no ventral suckers; legs ending in claws; body divided into cephalothorax and abdomen; the female with a clavate hair between legs I and II—
not parasitic on birds or mammals TARSONEMID.E
Without tracheæ; no such clavate hair 2
2. Genital suckers usually present; not parasitic on birds or mammals; skin usually without fine parallel lines 3
Genital suckers absent; parasitic on birds or mammals; skin with fine parallel lines 4
3. Legs short, without clavate hair on tarsi I and II; living on insects. CANESTRINID.E
Legs longer, with clavate hair on tarsi I and II; not parasitic (except on bees) TYROGLYPHID.E
4. Possessing some specially developed apparatus for clinging to hairs of mammals
LISTROPHORID.E
Without such apparatus 5
5. Living on the plumage of birds ANALGESID.E
Not on plumage of birds, but in living tissues 6
6. Vulva longitudinal; in skin and cellular tissue of birds CYTOLEICHID.E
Vulva transverse; in skin of mammals and birds SARCOPTID.E

GAMASOIDEA.

1. Parasitic on vertebrates; mandibles fitted for piercing; body sometimes constricted
DERMANYSSID.E
Free, or attached to insects, rarely on vertebrates, never on birds 2
2. First pair of legs inserted within the same body-opening as the oral tube; genital apertures surrounded by the sternum UROPODID.E
First pair of legs inserted at one side of the mouth-opening; male genital aperture usually on the anterior margin of sternal plate GAMASID.E

ORIBATOIDEA.

Cephalothorax movably attached to the abdomen; palpi four-jointed...HOPLODERMIDÆ
 Cephalothorax not movable; palpi five-jointed.....ORIBATIDÆ

IXODOIDEA.

No scutum; no ventral shield; mouth-parts of adult not prominent from above;
 no pulvillus to tarsus in adults.....ARGASIDÆ
 Scutum present; sometimes ventral shields; mouth-parts of adult prominent from
 above; pulvillus to tarsus of adults.....IXODIDÆ

EUPODOIDEA.

Palpi often geniculate, or else fitted for grasping prey; mandibles large and
 snout-like; cephalothorax with four long bristles above, two in front, two
 behind; last joint of leg I longer than preceding joint, often twice as long
 BDELLIDÆ
 Palpi never geniculate, nor fitted for grasping prey; beak small; cephalothorax
 with bristles in different arrangement; last joint of leg I shorter or but little
 longer than preceding joint; eyes when present near posterior border. EUPODIDÆ

TROMBIDOIDEA.

1. Legs I and II with processes bearing spines; skin with several shields; coxæ
 contiguous.....CECULIDÆ
 Legs I and II without such processes; few if any shields.....2
2. Palpi much thickened on base, moving laterally, last joint often with two pecti-
 nate bristles; no eyes; leg I ending in several long hairs, adult sometimes
 parasitic.....CHEYLETIDÆ
 Palpi less thickened, moving vertically; eyes usually present; leg I not ending in
 long hairs.....3
3. Coxæ contiguous, radiate; legs slender, bristly; body with few hairs; no dorsal
 groove; tarsi never swollen.....ERYTHREIDÆ
 Coxæ more or less in two groups, legs less bristly.....4
4. Body with fewer, longer hairs; often spinning threads; no dorsal groove; tarsi
 never swollen; mandibles styliform (for piercing).....TETRANYCHIDÆ
 Body with many fine hairs or short spines; not spinning threads; often with
 dorsal groove; tarsi often swollen.....5
5. Mandibles chelate (for biting).....TROMBIDIDÆ
 Mandibles styliform (for piercing).....RHYNCHOLOPHIDÆ

HYDRACHNOIDEA.

Mouth-parts carried upon a distinct beak; no ventral suckers; living in the sea
 HALACARIDÆ
 Mouth-parts not carried upon a beak; usually suckers near the genital openings;
 usually in fresh water.....HYDRACHNIDÆ

Family EUPODIDÆ.

The Eupodidæ is a small family of small mites, several species of which are among our most common acarians. They are soft-bodied, delicate mites, with moderately long to very long legs. The body shows more or less distinctly the division into cephalothorax and abdomen; the former usually bears an eye each side; the latter carries

a few simple hairs. The palpi are short and simple, four-jointed, and with only a few hairs. The mandibles are rather small, but distinctly chelate; in one genus they are very large. The legs are six or seven jointed and terminate in two simple claws, and often with a median plumose pulvillus. The venter has the usual openings, but in *Notophallus* the anal aperture is on the dorsum of the abdomen. These mites can run rapidly, and *Eupodes* can make considerable leaps. Most inhabit the ground, but some are found on the leaves of trees. All are predaceous and feed on various small insects or insect eggs. They seem to delight in cold, damp places, and can be found in winter still active among and under fallen leaves. They are among the most common acarians in high latitudes, and are also frequent in caves, both of this country and of Europe, where their simple and primitive structure is well suited to the conditions. Their internal anatomy has lately been investigated by Nordenskiöld, who finds that *Rhagidia* is among the most primitive of the Trombidoidea. The œsophagus, which opens near the tip of labium or underlip, is very slender, and after passing through the large "brain," enters a very large stomach. From the upper part of this arises the intestine, which soon expands into a very large colon, opening at the tip of body. The eggs, as far as known, are laid upon the surface frequented by the adult. The larvæ resemble the parent, while the nymph differs only in size. There is no sexual dimorphism. Most of the common species vary a great deal in markings, the consequence being that Koch described each of the common European species under many different names, several having from ten to twenty synonyms. Our forms have been collected only in the northeastern States.

Five of the described genera occur in the United States; these may be tabulated as below:

- | | |
|-------------------------------------------------------------------------------|--------------------|
| 1. Legs extremely slender, anterior pair much more than twice as long as body | <i>Linopodes</i> |
| Anterior legs much shorter | 2 |
| 2. Hind femora much thickened; anterior legs much longer than others | <i>Eupodes</i> |
| Hind femora not thickened | 3 |
| 3. Anal opening on the dorsum; mandibles small | <i>Notophallus</i> |
| Anal opening on venter | 4 |
| 4. Mandibles very large; legs longer than body | <i>Rhagidia</i> |
| Mandibles small; legs scarcely as long as body | <i>Tydeus</i> |

Our one species of *Linopodes* is a very pretty pale yellowish or reddish mite, with some white marks, one on the back is in the form

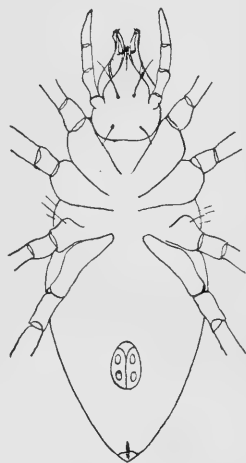


FIG. 7.—VENTER OF AN EUPODID.

of a T. It is common on the ground under pieces of wood, bark, etc., that have lain there sometime. The first pair of legs is used as feelers. Usually the mites walk slowly, but when disturbed run very rapidly. We have several species of *Eupodes*, all more or less marked with red. The common one, *E. variabilis* Banks, is found in the same places as *Linopodes*. Another species occurs on the seashore between tide-marks.

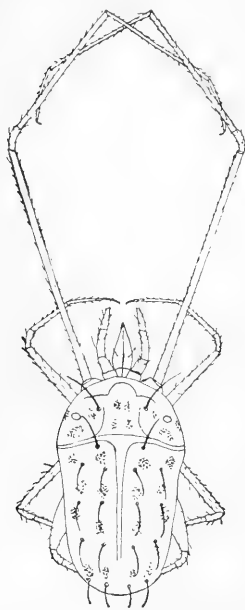


FIG. 8.—LINOPODES ANTENIPES.

has described a species of *Tydeus* (*T. molestus*) as attacking man, much on the "red-bug" style. *Rhagidia* is a remarkable genus. The



FIG. 10.—TYDEUS,
BEAK AND LEG I
FROM BELOW.

species are pale or whitish in color, and occur under damp, fallen leaves and on moist soil. It is much larger than the other species of this family, and sometimes fully one millimeter long.

Its structure is in many ways very similar to that of certain Solpugida and suggested to Thorell its generic name, which is a diminutive of *Rhax*, a genus of Solpugida. It is probable that it is the most primitive of all existing mites; and points to the close relationship of the Acarina to the Solpugida. Our common species, *R. pallida* Banks, is found throughout the country, but more commonly in the north. Other species are found in Europe, Japan, Kerguelen, Chile, and the arctic regions.

A European mite of this family, *Erynetes limaceum* Koch, some-

The species of *Notophallus* are blackish, with a red spot above, and red legs. They occur in damp fields, under stones, or in moss. But one species of *Tydeus* is known from the United States, *T. gloveri* Ashmead. It occurs on orange leaves in Florida, and feeds on the young and eggs of scale insects (*Mytilaspis* spp.). It is pale reddish or yellowish in color and has a subpyriform body, with rather short legs. Moniez

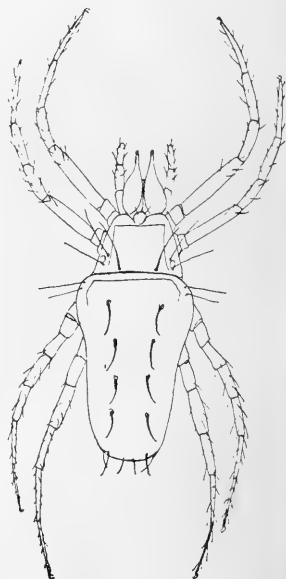


FIG. 9.—RHAGIDIA PALLIDA.

times occurs upon certain species of slugs (*Limax*), and sometimes attached to a fly (*Sarcophaga*). In this country a mite (*Hypopus concolor* Haldeman) has been recorded by Binney as found upon a snail. It may belong to this genus, *Erynetes*. *Pentthaleus* embraces several species, having a black body, with a red spot behind, and red legs. Here we may also refer to the genus *Alycus*, which is placed in a separate family. It looks much like a minute *Trombidium*, but has simple palpi. Two forms are known in Europe.

Family BDELLIDÆ.

The members of this family are known as "snout mites," from the appearance of the beak or rostrum. The body shows distinctly the division into cephalothorax and abdomen, the two hind pairs of legs apparently arising from the latter. The cephalothorax is subtriangular, with a few long bristles above and usually one or two eyes on each side, commonly near the posterior corner. The mandibles are large, slender, tapering,

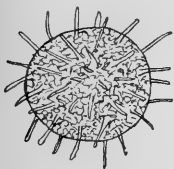


FIG. 12.—EGG OF BDELLA.

ing, more or less united along the median line, and together form a prominent cone in front. They are chelate in the typical genus, but in some of the other genera end in one claw. The palpi arise apparently from near the base of the mandibles, but really from a part of the body below them. They are either three or five jointed, the second joint being the longest. In some forms they are provided with spine-like bristles, but usually with fine hairs, the terminal ones often of great length. The antennæ are frequently elbowed between the second and third joints. The abdomen is usually broadest at the shoulders and tapering, but rounded behind; it bears only a few hairs or bristles.

The venter has the usual two apertures near the posterior part, the genital usually the larger. The legs are quite long and slender, with a few scattered small hairs. They terminate in two claws with a median hairy brush beneath. The hind coxæ are well separated from the anterior pairs.

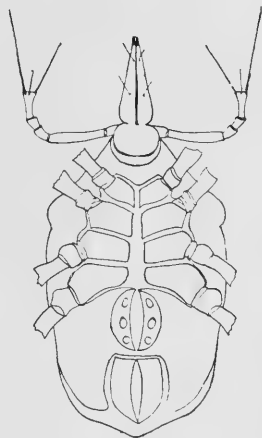


FIG. 11.—VENTER OF A BDELLA.

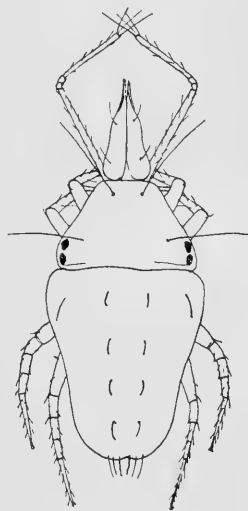


FIG. 13.—BDELLA PEREGRINA.

The internal anatomy has been studied by both Karpelles and Michael. It is peculiar in several respects. There is a large sac or diverticulum connected to the œsophagus above. Michael has termed it the *receptaculum cibi*, and believes its purpose is to store the food for a short time. The ventriculus ends blindly; there being no communication to the anus. There are three pairs of glands in the anterior part of the body, besides one large median gland. One pair opens at the base of the mandibles and their function is unknown. Two pairs open into a common duct which leads to the mouth; they are probably salivary glands. The supra and sub-œsophageal ganglia are more distinctly separated than in other mites that have been examined. The pharyngeal nerve (which in other mites is single) in *Bdella* is split in two parts. The male organs are remarkable for possessing two single and one pair of accessory glands, whose function is little understood. In the female there is but one oviduct.

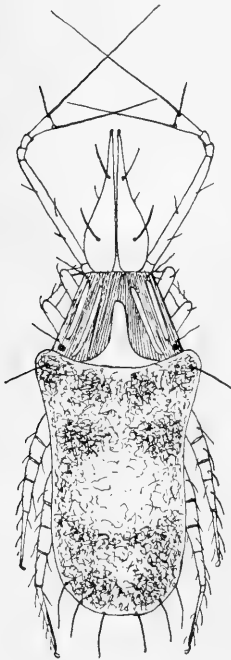


FIG. 11.—*BDELLA TENELLA*.

Mr. Trägårdh has figured the egg of *B. arctica*; it is nearly spherical, and with a number of long spines scattered over the surface. The larva and nymph have much resemblance to the adult. They are never parasitic, and there is no sexual dimorphism.

The species are usually red in color, but some are blackish. They are predaceous in habit and wander about in search of food—any small creature they can find. The palpi serve as tactile organs in most genera, but in *Scirus* they are used to capture and hold the prey. These mites can run quite fast, and move backward as well as forward. Several species are known from the Arctic regions. Four genera have been recognized in this country, and one more (*Scirula*) is known in Europe. They may be separated by the following table:

- | | |
|---------------------------------------------------------------------------------------------------------------------|----------------|
| 1. Mandibles chelate; two eyes each side; palpi geniculate, and ending bluntly with two or more long bristles | 2 |
| Mandibles ending in one claw; no eyes, or only one each side; palpi not geniculate, and ending in a claw | 3 |
| 2. No median eye on front margin of cephalothorax; tip of tarsus with one or two plumose hairs each side..... | <i>Bdella</i> |
| A median eye on front of cephalothorax; tip of tarsus without plumose bristles. | <i>Cyta</i> |
| 3. Palpi of three joints, and without spine-like bristles, one eye each side on cephalothorax | <i>Eupadus</i> |
| Palpi of five joints; and with spine-like bristles; no eyes..... | <i>Scirus</i> |

Trouessart has separated the group of *Scirius* from the Bdellidæ and placed them as a family of the Trombidoidea; this does not appear natural to me. Of *Scirius* but one species has been described in the United States; it lives in damp places, and is very active. Of *Bdella* we have a number of species, and some are common. They usually inhabit moist places, moss, rotten bark, etc. One species (*B. marina* Packard) is common along the north Atlantic shore between tidemarks. *B. cardinalis* and *B. peregrina* are common on damp soil; *B. tenella*, under rotten bark. Michael has recorded finding a species of *Bdella* abundantly on the web of a tube-weaving spider, *Amaurobius ferox*. The mites were not disturbed by the spider and evidently felt much at home. They doubtless fed on some of the small insects disdained by the spider. The genus *Cyta* is very similar to *Bdella*; our one species (*C. americana*) occurs in damp fields; it was formerly known as *Ammonia*, which name is not only later, but also preoccupied.

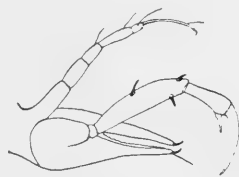


FIG. 15.—MANDIBLES AND PALPUS OF SCIRIUS.

Family CHEYLETIDÆ.

The Cheyletidae are a small family of tiny mites, differing considerably in habits and structure among themselves. The typical forms are distinguished by the enormous palpi attached to a distinct beak.

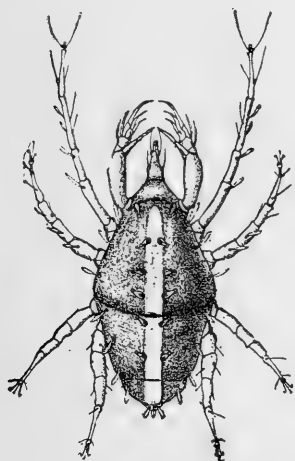


FIG. 16.—CHEYLETUS SP. (PERGANDE).

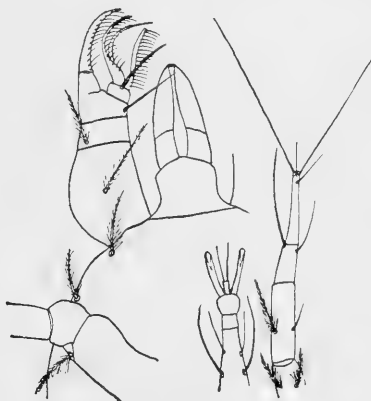


FIG. 17.—CHEYLETUS PYRIFORMIS: BEAK AND PALPUS, TIP OF LEG I, AND CLAWS OF LEG II.

The palpi are three to five-jointed, and frequently have a minute movable tubercle or papilla near the tip on inner side, which in some forms is tipped with one or two pectinate bristles. This papilla is evidently homologous with the "thumb" of the Trombididæ. The beak is plainly

separated from the body by a deep constriction, and in front has the circular mouth-opening or camerostome, through which the mandibles may be extended and retracted. The body is usually oval; the skin soft, occasionally with chitinous plates, and in many forms finely striate. The division between the cephalothorax and abdomen is rarely present. The body bears a few hairs, sometimes in the form of scales. The legs are generally short, five-jointed, and usually end in two claws, with a bunch of hairs or a pectinate bristle between them. In some species the front legs terminate in bristles, and appear to have a tactile function; in others the front legs are transformed into clasping organs. Sometimes there is an eye on each side of the cephalothorax, but it is

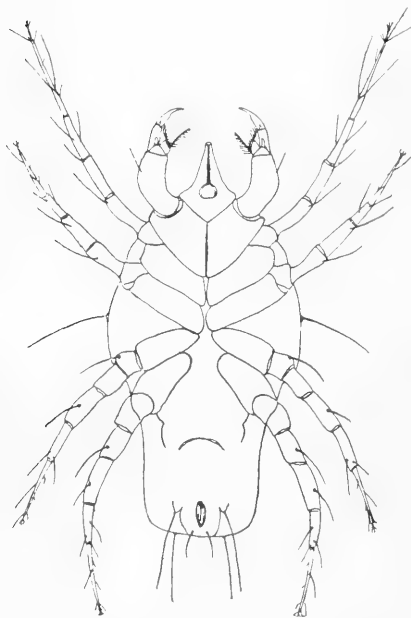


FIG. 18.—CHEYLETUS AUDAX, FROM BELOW.

not often distinct. The mandibles are commonly long and needle-like, fitted for piercing tissues; in one genus, however, they have two points, indicating their chelate origin. The female genital aperture is just in front of the anus, which is at tip of the venter. The male aperture is behind the anus, and often near the middle of the dorsum. The penis is very prominent, long, slender, and curved, and is often found partially extruded. The internal anatomy of the Cheyletidae has not been thoroughly examined. The digestive tube is simple; the stomach is provided with four large cæca. In one genus, *Sarcopterus*, there is no anus; the food of this mite is of such a nature as to be completely digested. The

respiratory system is perhaps more complete than that of other families. There are two large tracheal trunks starting from the beak and extending back to near the tip of the body, each giving off many smaller branches which ramify throughout the body. From some accounts it appears that the main trunks are composed of two or three separate tracheæ. These main trunks are connected to each other near their origins. The spiracles are at the sides of the beak, and in some cases there are two also near the median line. These spiracles are sometimes trumpet-shaped. The nervous system consists of a circle around the œsophagus and ten branches from it, four in front and six behind. Two of these branches go to the beak, others to the legs, and two to the posterior part of body.

The eggs are deposited singly or in clusters, and by some species a web is spun over them, or at least a few threads to hold them in place. In a few species the mother remains to guard the cluster for some time. The larva, upon hatching, has much resemblance to the adult, but, of course, with only six legs. The nymph looks still more like the parent, and there are but few differences between the sexes, save that the male is smaller. Several authors have noted the existence of parthenogenesis in some species. Cheyletidae feed on animal life, some being predaceous, others parasitic. A few may be said to belong to both groups, inasmuch as they occur upon certain animals only to prey on the parasites of the host.

Only a few genera are known, and of these but four have been recorded from this country.

1. Anterior leg fitted to clasp hair; hind legs with but one claw; palpi small... *Myobia*
Anterior legs not so modified; hind legs with two claws, or else leg I with two claws.....2
2. Body elongate, at least three times as long as broad, palpi not swollen at base, no distinct "thumb" or papilla.....3
Body not twice as long as broad, the papilla usually present.....4
3. Anterior legs much larger than posterior pairs, and ending in a long bifid pulvillus..... *Picobia*
Anterior legs barely longer than others, without such pulvillus..... *Syringophilus*
4. Body about as broad as long; legs very short and stout; palpi not swollen on outer side at base; parasitic forms.....5
Body plainly longer than broad; legs more slender; palpi usually swollen on outer side at base; hind legs with claws; not true parasites.....6
5. Hind legs each with two claws..... *Psorergates*
Hind legs without claws; with several long hairs..... *Harpyrhynchus*
6. Tubercle, or papilla, of palpus with one or two pectinate bristles..... *Cheyletus*
Tubercle, or papilla, of palpus with only simple hairs..... *Cheyletiella*

Cheyletus contains about one dozen species. They are very small (about one-half millimeter in length), live freely, and prey upon other mites and small insects. They seize the prey with their big palpi, insert the mandibles, and suck it dry. Some have thought that there must be poison glands in the palpi, since the prey ceases movement very soon after capture. Several species have some fan-shaped hairs or scales on the body and appendages. These constitute the subgenus *Cheyletia* Haller. Two species, one of them, *C. clarispinus* Banks, have been found attached, in adult condition, to Hemiptera of the genus *Aradus*. They are evidently not parasitic, but use the insect only for transportation. Another of our species, *C. pyriformis*, was found feeding on a scale insect on grapevine, another on *Cicada* eggs, and a third, *C. audax*, attacking Tyroglyphids among cabbage seed.

Cheyletiella includes several species in which the palpi are not as large as in *Cheyletus*. They usually occur on birds where they feed on the other mites present. They have been called auxiliary parasites. One species, *C. parasitivorax*, uses the rabbit's fur as a hunting forest,

where it destroys the *Listrophorus* mites. No species have as yet been recorded from this country. *Harpyrhynchus* (formerly *Sarcopterus*) is represented by a few species that have a very short, broad body, with very short legs, the hind pairs ending in a bunch of bristles. They occur in the hair follicles of several birds, where they form tumors. The eggs are very large for

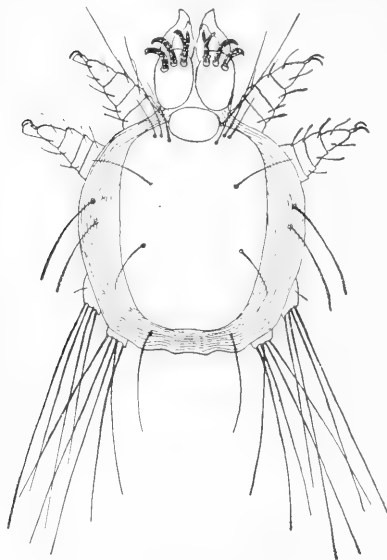


FIG. 19.—HARPYRHYNCHUS LONGIPILUS, FEMALE.

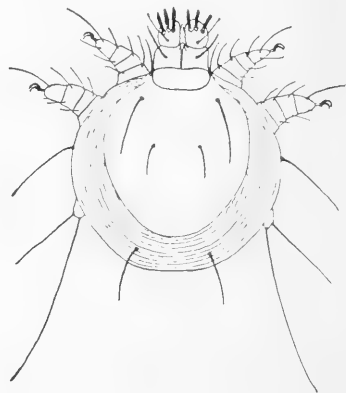


FIG. 20.—HARPYRHYNCHUS LONGIPILUS, LARVA.

the size of the mite. One species, *H. longipilus* Banks, has been taken in the United States in a tumor under the wing of a cross-bill. The

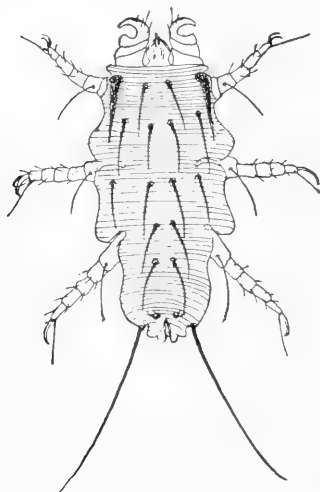


FIG. 21.—MYOBIA MUSCULLI.

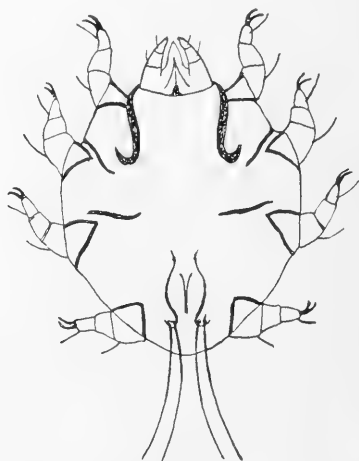


FIG. 22.—PSORERGATES SIMPLEX.

genus *Psorergates* was described by Tyrrell from Canada. It lives parasitically on the house and field mouse, in cavities or little cells just beneath the surface of the skin. It has a nearly round body,

with very short, stout legs, each ending in two stout claws. It has since been found in various parts of Europe, and was described by Michael under the name of *Goniomerus musculus*.

The genus *Myobia* was based on a species from the head of the house mouse. All the legs are very short and thick, but the first pair is heavier than the others and transformed into an organ fitted to grasp the hair. The eggs are fastened to the hair of the mouse. The nymph differs considerably from larva and adult in legs and beak. The palpi are atrophied. In this stage it burrows into the hair follicles, feeds there, and transforms. It is not supposed to suck blood, but to feed on matter secreted by the skin of the host. Several other species are found on allied mammals, and one infests bats. Osborn has recorded the presence of *M. muscubi* in this country.

Picobia and *Syringophilus* are closely allied. They have elongate bodies provided with long bristles. They live in the quills of the feathers of various birds, coming out only for breeding and migration. One of these was recorded from Arizona by Hancock as *Picobia villosa*, which Trouessart states is the same as *S. bipectinatus* Heller of Europe. Trouessart also claims that this is not an adult mite, but that it is a stage (which he calls "syringobial") in the life of a *Cheyletiella*. Nörner, however, describes and figures the male and egg of this species.

Family ERYTHRÆIDÆ.

There are few species of mites in this family, but one is very common and beneficial. They are at once separated from all other Trombidioidea in that the coxæ are close together and arranged in a radiate manner. The body shows no complete division between cephalothorax and abdomen, although in the typical genus the division is often indicated just behind the third pair of legs. The body, which is usually short and broad, is provided with many stout bristles. In front on each side are one or two simple eyes. The mandibles are quite large and prominent and taper to a point which is tipped by a curved claw. The palpi are prominent, but slender; in *Erythræus* with a long "thumb," but in *Anystis* the last joint is terminal. The legs are large and long, gradually tapering and provided with many long hairs or bristles. They are six or seven jointed, and terminate in two or three claws. In some species the tarsus is divided into a number of small joints. On the venter are genital and anal openings, both quite elongate. The young resemble the adult, except in having but six legs.

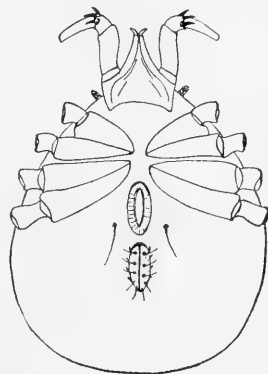


FIG. 23.—VENTER OF ANYSTIS.

There are four genera, three of which, *Erythræus*, *Anystis* (formerly *Actineda*), and *Gekobia*, are known from the United States. *Anystis* and *Erythræus* are free and predaceous, feeding on any small insects or acari that they may come across. Their movements are excessively rapid and erratic, sometimes whirling about in a zigzag course like a particle of dust blown by the wind. In *Anystis* the body is triangular and the palpi are four-jointed. In *Erythræus* the body is more elongate, and the palpi five-jointed.

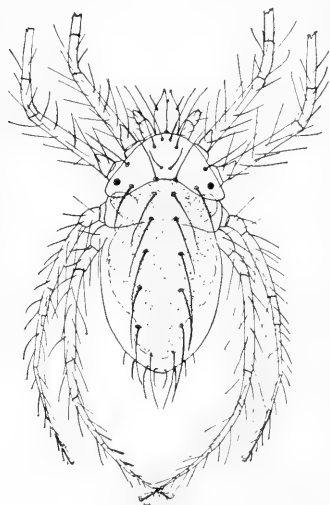


FIG. 24.—*ERYTHRÆUS SPINATUS*.

Our one species of *Anystis*, *A. agilis* Banks, is commonly found running over the leaves of herbs and shrubs in the search for prey. It is red in color. I have seen it feed on aphids, on small caterpillars, and on the young larvæ of the currant saw-fly. The young before transformation spins a white silken web on a leaf, or crevice of bark, and beneath it changes to the adult form.

Species of *Erythræus* are known to occur about houses, but most of them live on trees. They are usually red in color, but some are marked with white spots and stripes. They are not very common in our country, but two species have been described. *Gekobia* is found attached to various reptiles, especially lizards. Three species are known from Europe, and one, *G. texana*, is found on *Sceloporus floridanus* in this country.

The typical species is very broad, broader than long, and the coxæ all close together; in *G. texana* and one European species the body is longer than broad and the hind coxæ separated from the anterior pairs. The mandibles have a peculiar structure; they consist of a stout rod with a short, acute, stout spur near the tip. They are supposed to suck blood from the lizards; nothing is known of their earlier stages.

Berlese has recently changed *Erythræus* to *Erythacarus*, claiming that the type of *Erythræus* is a *Rhyncholophus*.

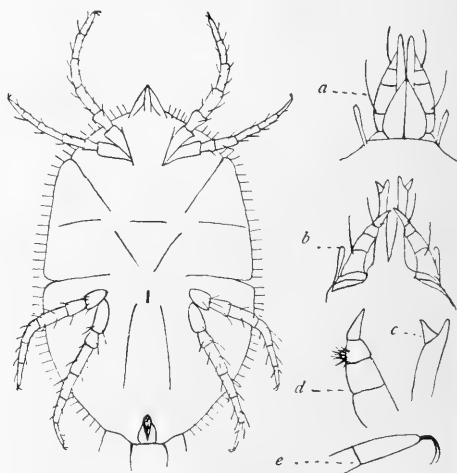


FIG. 25.—*GEKOBIA TEXANA*. a, BEAK ABOVE; b, BEAK BELOW; c, TIP OF MANDIBLES; d, PALPUS; e, TARSUS WITH CLAWS.

Family TETRANYCHIDÆ.

The members of this family, commonly known as "red spiders," have for many years attracted attention, owing to their ravages to cultivated plants. Since many of the species can spin a silken thread, they have also been called "spinning mites." Their structure presents few remarkable characters. The body is oval or elliptical, provided with a few, mostly long, hairs, arranged in four rows. The cephalothorax is separated from the abdomen by a furrow, and bears on each side one or two simple eyes. The palpi are short, the penultimate joint ending in a claw. The last is "thumb-like" and bears one or more appendages called "fingers." In some species the palpus of the male has a short curved spine at the tip on the upper side of the third joint. The mandibles have their basal joints united in a plate; the apical joint, being very long and flexible, is fitted for piercing plant tissues, and is known as the stylet. The legs are moderately slender, the first pair the longest, with scattered hairs, and ending in one or two claws. In many species of *Tetranychus* the claw is split into four pieces, whence the name. On the under side of the abdomen are two simple openings, the basal the genital, the other the anal. The former in the female is usually transverse. In the male it is longitudinal and often shows the slender curved penis.

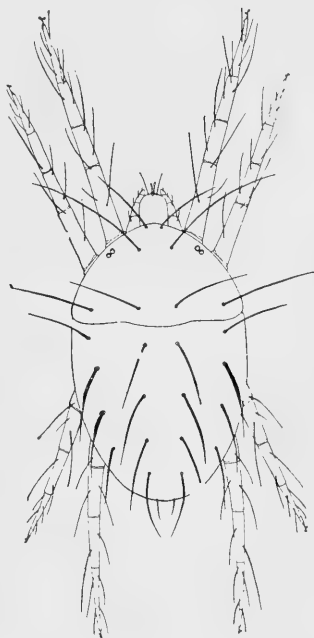


FIG. 26.—TETRANYCHUS BIMACULATUS.

The genera recognized in our country may be separated as follows:

1. Front margin of cephalothorax with four scale-like projections, body with scale-like hairs above; leg I longer than body *Bryobia*.
No scale-like projections on front of cephalothorax 2.
2. All the legs much longer than body, which is short and broad; rostrum not prominent from above *Neophyllobius*.
Few of the legs but little longer than body 3.
3. Palpi ending in a distinct "thumb;" not very slender 5.
Palpi not ending in a distinct "thumb" 4.
4. Palpi very small and slender; legs short and heavy, usually rugose; eyes distinct *Tenuipalpus*.
Palpi of moderate size, legs longer, not rugose; eyes indistinct or absent *Tetranychoides*.
5. Body twice as long as broad; legs very short *Stigmaeus*.
Body one and one-half times as long as broad; leg I longer than body *Tetranychus*.

Two common European genera, *Caligonus* and *Raphignathus*, have not been found in this country. They are very small and of a bright red color. In the genus *Bryobia* we have but one species, *B. pratensis* Garman, known as the clover-mite. It is very abundant in many localities. In the West it is injurious to fruit trees; in the East

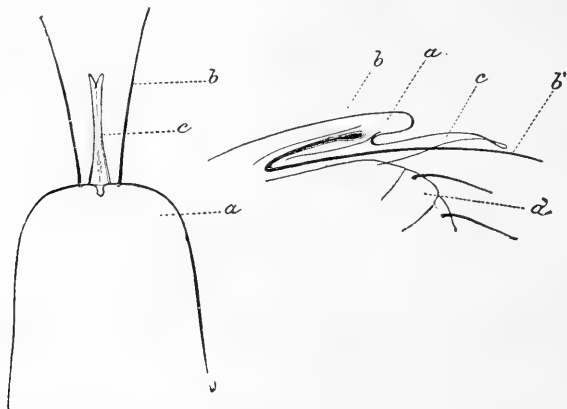


FIG. 27.—TETRANYCHUS, MANDIBULAR PLATE, DORSAL AND LATERAL VIEWS. *a*, PLATE; *b*, STYLET; *c*, SPINA; *d*, PALPUS.

it more commonly affects clover and annual plants. The eggs are laid in the autumn in great numbers, attached to the branches and twigs of trees. They are red, very small, and round, and are often mistaken for the eggs of plant-lice. The adults in the autumn often seek winter quarters in houses and may become a great nuisance. Both

the mites and their eggs can be killed by a spray of kerosene emulsion.

In *Tetranychus* the body is subpyriform, and provided above with about twenty-four to thirty-six bristles arranged in four rows. The species of this genus can spin a thread, which, when they are very abundant, becomes a dense mesh or web, visible at a considerable distance. The

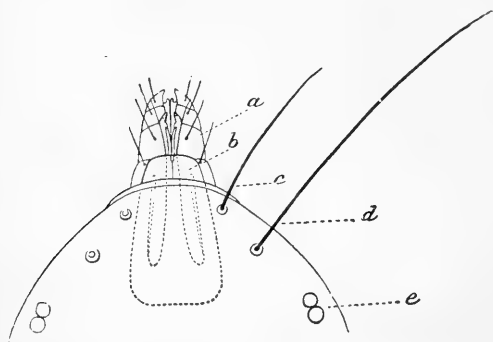


FIG. 28.—TETRANYCHUS, CEPHALOTHORAX FROM ABOVE. *a*, PALPUS; *b*, MANDIBULAR PLATE; *c*, FRONTAL BRISTLE; *d*, SUBFRONTAL BRISTLE; *e*, EYES.

spinning organ is not definitely located, but the thread arises from or near the genital or anal opening. The web does not appear to afford the mites any protection, but at times seems to serve to hold the eggs in place. It may be either on the upper or lower surface of the leaf. The mites are supposed to hibernate under or among fallen leaves, in the spring ascending trees to start new colonies.

Each female may lay from five to ten eggs a day for a period of eight to twelve days; the young hatch in from three to five days, and in about five days more are adult. A succession of broods is continued

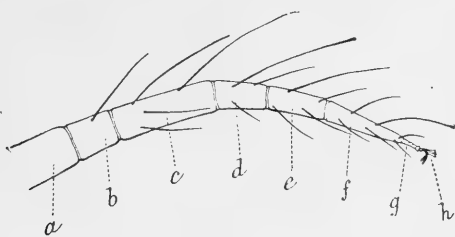


FIG. 29.—TETRANYCHUS LEG. a, COXA; b, TROCHANTER; c, FEMUR; d, PATELLA; e, TIBIA; f, TARSUS; g, ONYCHIUM; h, CLAWS.

throughout the summer, but wet weather is apt to stop or greatly retard their development.

The mites ordinarily move slowly, but when disturbed can run quite rapidly. For the greater part of the time they remain in one place

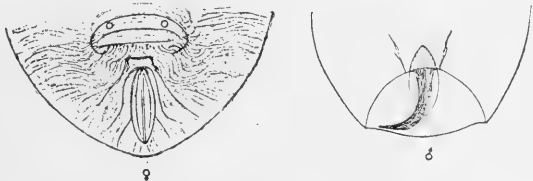


FIG. 30.—TETRANYCHUS, GENITAL ORGANS.

sucking the juices from the leaf. In the spring some species attack the buds. Several of our species are very abundant and destructive. The common greenhouse species, known as “the red-spider,” and which also occurs on many outdoor cultivated plants, is *T. bimaculatus*

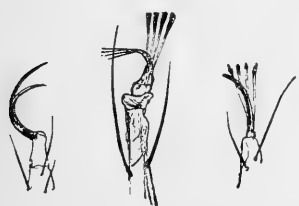


FIG. 31.—THREE STYLES OF CLAWS OF TETRANYCHUS.

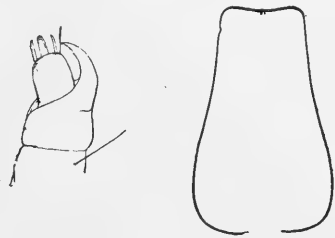


FIG. 32.—TETRANYCHUS GLOVERI, PALPUS AND MANDIBULAR PLATE.

Harvey; it is probably the *T. eucumeris* of Boisduval. Specimens of this species often vary greatly in coloration; the members of each colony, however, usually being alike. *T. mytilaspidis* Riley is abundant on orange leaves in Florida. In this species the abdominal bristles arise from warts or tubercles, and the tarsus has two simple

claws. The most abundant species on orange is a yellowish form, *T. scarmaculatus* Riley. At times it is a very serious pest to orange culture, and an article upon it is found in the Report of the Ento-

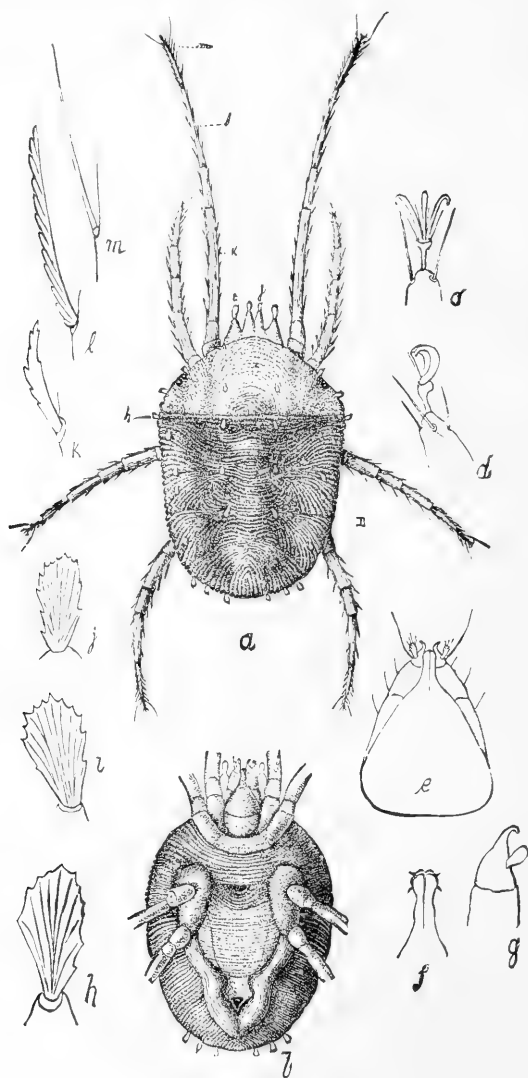


FIG. 33. BRYOBIA PRATENSIS—*a*, FEMALE FROM ABOVE; *b*, FEMALE FROM BELOW; *c* AND *d*, TARSAL CLAWS; *e*, BEAK FROM BELOW; *f*, BEAK FROM ABOVE; *g*, PALPUS; *h*, *i*, *j*, *k*, *l*, *m*, SCALES AND SPINES OF VARYING SHAPE (BUREAU OF ENTOMOLOGY).

mologist for 1889. They occur on the under surface of the leaves; the eggs are colorless or pale greenish-yellow.

In *T. bicolor* Banks, a species common on the leaves of oak and chestnut, the tarsus has but one claw. The form occurring on cotton is known as *T. gloveri* Banks; it is bright red, and greatly resembles

the common greenhouse species. There are several remedies for red spider. One is to keep the plants moist, spraying them with water once a day. But the best remedy is flowers of sulphur applied either as a dry powder, or as a spray. Bisulphide of lime is also an effective remedy, and tobacco water is sometimes used. The species of *Stigmaeus* are

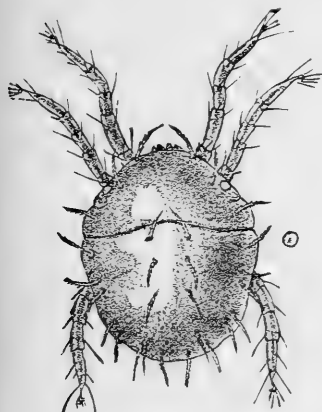
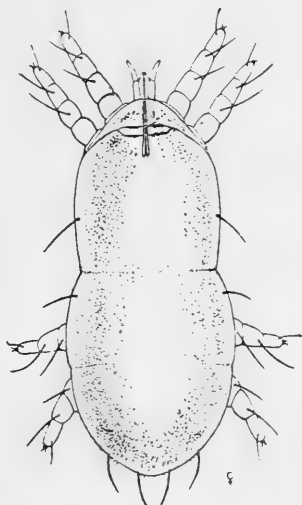


FIG. 34.—*BRYOBIA PRATENSIS*, LARVA
(BUREAU OF ENTOMOLOGY).



FIG. 35.—*STIGMAEUS FLORIDANUS*; MITE, MOUTH PARTS,
AND CLAWS.



elongate and have short legs. They are smaller than *Tetranychus*, but live in the same manner. Our one species, *S. floridanus* Banks, occurs upon the bases of the imbricated leaves of the pineapple. It

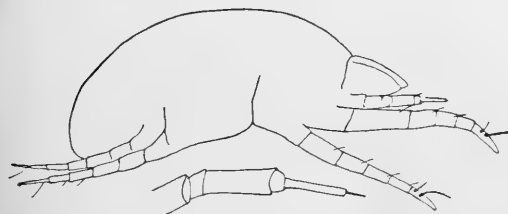


FIG. 36.—*TETRANYCHOIDES CALIFORNICA*, AND PALPUS EN-
LARGED.

is of considerable economic importance owing to the fact that its punctures give certain destructive fungi access to the tissue of the leaf. The remedy, Prof. Rolfs found, is to place a small quantity of tobacco dust in the bud of the plant, the dew and rain washing it down upon the mites. One application is usually sufficient.

In *Neophyllobius* the body is short and the legs are very long; the tarsal joint slightly swollen in the middle and ending in two claws. Our only known species was taken on oak leaves in Alabama.

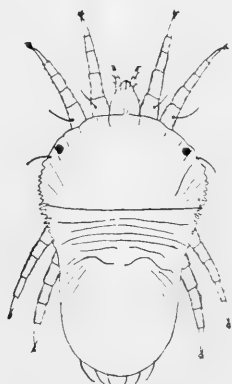


FIG. 37.—*TENUIPALPUS CALIFORNICUS*.

In *Tenuipalpus* the palpi are very small and slender, and end in two or four short bristles. The species are smaller than *Tetranychus*, and red in color. I have seen one species from our country, namely,

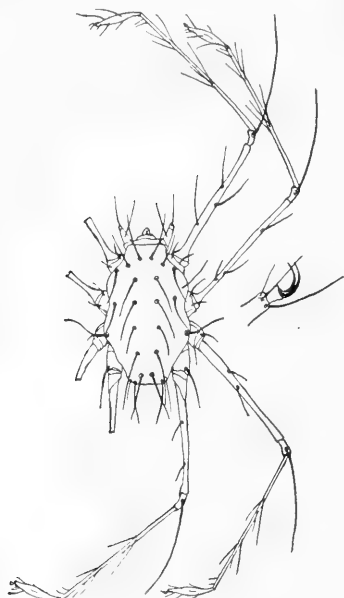


FIG. 38.—*NEOPHYLLOBIUS AMERICANUS*.

Tenuipalpus californicus. It appears to be very numerous on the oranges in California, and doubtless causes some injury. Inasmuch as it is very small, and does not breed very fast, it will probably never be a pest of prime importance. It may be destroyed by the treatment used against "red-spider."

Tetranychoides is based upon one species, *T. californica*, which occurs in small colonies on the leaves of orange. Each colony is usually in a slight depression, and is evident to the naked eye as a snow-white patch, this appearance being due to the fact that the molted skins are retained attached to the leaf. The mites, which are almost colorless, and their eggs, are located among these molted skins. They do not appear as yet to be numerous enough to do any appreciable damage.

Three other genera have been recorded in Europe, *Eupalopsis*, *Cryptognathus*, and *Tetranychopsis*, each with but one or two species.

Red-spider damage is common in nearly all foreign countries, but the generic positions of the mites that cause it are not easily discernible from the meager descriptions. In India and Ceylon one species, called *Tetranychus bioculatus*, is a very serious pest to the tea plant.

Family RHYNCHOLOPHIDÆ.

These common mites are similar in many ways to the harvest-mites (Trombidiidæ) and by many authors have been united to them. They are much like *Trombidium* in appearance, but nearly all are of more slender proportions and more rapid in motion. The body is usually divided, although not so plainly as in the Trombidiidæ, into two parts. The cephalothorax is quite large and on the same plane as the abdomen. Along the middle of the cephalothorax is a line or furrow, known as the dorsal groove or crista. It is usually enlarged at the posterior end, sometimes in the middle, and also at the anterior end, where it often includes a frontal tubercle. There are one or two simple eyes on each side of the cephalothorax; they are always sessile. In one genus (*Smaris*) there are also two eyes close together near the middle of the anterior margin. The palpi are prominent, five-jointed, the last forming a "thumb" to the preceding, which ends in a claw.

The mandibles are slender, needle-like, and retractile, thus differing greatly from those of *Trombidium*, and forming the warrant for a separate family.

The legs are commonly quite slender, the hind pair sometimes more than twice as long as the body. They are seven-jointed and terminate in two small claws. The last joint, or tarsus, is nearly always shorter than the preceding joint, and in the first and fourth pairs often swollen. The body and legs are densely covered with bristles or hairs, sometimes both. The hinder pair of legs are always quite remote from the anterior pairs. The genital opening is between the hind coxæ; the anal opening is usually close behind it.

They are usually found on the ground, sometimes in very hot situations, and run over the surface or on low plants with great rapidity. Other species occur in moss or under

fallen leaves in woods, and one is abundant among the rocks near the top of Mount Washington. Several species appear to live in colonies, but most are solitary in habit. The eggs are deposited

on the ground or under stones, often in clusters. The larva is a six-legged mite attached to insects. When full fed they drop to the ground and become quiescent, and after a varying time transform to the adult.

There are several genera in the family, but only three are so far known from the United States. In *Smaris* the mouth-parts are retractile, and so are often invisible; the palpi are four-jointed and there is commonly an extra pair of eyes near the anterior margin, making

six in all. In *Smaridia* the mouth-parts are less retractile than in *Smaris*, and there are but four eyes. The palpi are five-jointed and the dorsal groove is sometimes swollen in the middle.

Thor, who has recently published on this and allied families, makes *Smaris* the type of a special family. He finds that in this genus there are no spiracles near the beak, as in other Prostigmata, and that there are no large tracheal trunks in the body. There are a great many fine

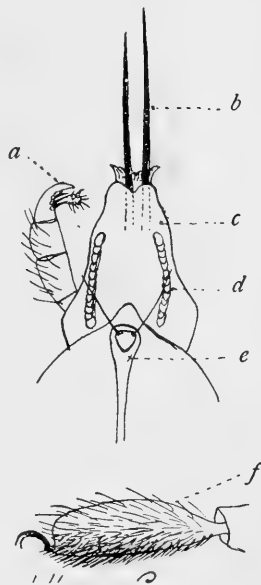


FIG. 39.—RHYNCHLOPHUS. a, PALPUS; b, MANDIBLES; c, BEAK; d, TRACHEAL PORES; e, DORSAL GROOVE; f, TARSUS.

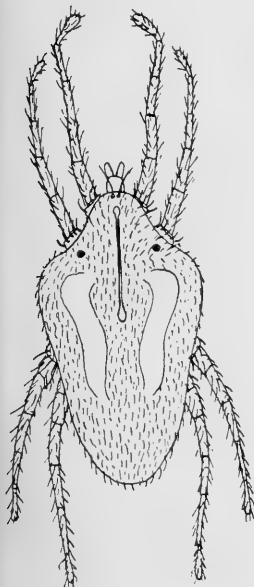


FIG. 40.—RHYNCHLOPHUS MACULATUS.

tracheae in this mite, and Thor believes that respiration is effected through the skin, the structure of which is rather peculiar. Upon these differences he bases a family; however, in my opinion, this is but more evidence (if such is needed) of the uselessness of a classification based on the respiratory system.

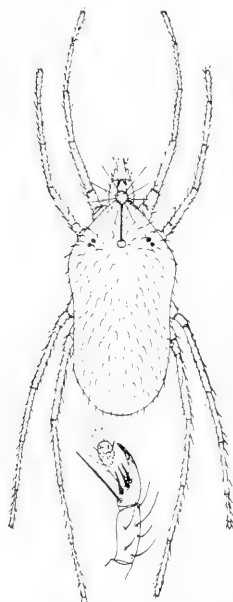


FIG. 41.—*RHYNCHLOPHUS SIMPLEX* AND PALPUS.

In *Rhyncholophus* the mandibles only are retractile; there are but four eyes, and the palpi are five-jointed. We have many species of this genus, and several of them are common and widely distributed. They are predaceous and suck the juices from any small insect that they are able to catch. One species has been found preying on the gloomy scale (*Aspidiotus tenebri-cosus*) and others are found feeding on the San Jose scale and other scale insects. In these situations they are often the prey of aphid-lions (*Chrysopa*).

Most of our species are uniform red in color, but *R. cinctipes* Banks has prettily banded legs, and *R. maculatus* Banks has

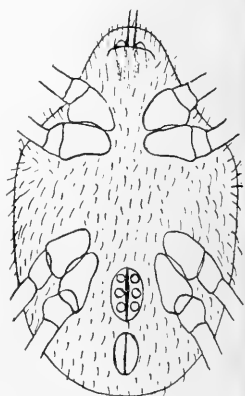


FIG. 42.—VENTER OF *SMARIS*.

several large pale spots on the dorsum. One of our species, *R. longipes*, has so extremely long legs that it resembles a minute Phalangid. The genus *Eatoniana* occurs in southern Europe and northern Africa; it is remarkable on account of the plume of hairs on the hind legs.

Family TROMBIDIIDÆ.

The "harvest mites," as they are popularly called, are recognized by the body being divided into two portions, the anterior (cephalo-thorax) bearing the two anterior pairs of legs, the palpi, mouth-parts, and eyes; the posterior (abdomen) is much larger and bears the two posterior pairs of legs. The mandibles are chelate, at least there is a distinct jaw or curved spine-like process. They also differ from the allied Rhyncholophidæ in that the last joint of leg IV is not or very slightly shorter than the penultimate, and



FIG. 43.—EGG OF *TROMBIDIUM*.

in that the last joint of leg IV is not swollen. The last joint of leg I usually is swollen, often more so than in the Rhyncholophidæ. They are always red in color, some, however, being much darker than others. The body is covered with bristles or feathered hairs according to the species. The palpi are five-jointed, quite prominent, often swollen in

middle, the penultimate joint ending in one or two claws, the last joint (often clavate) appearing as an appendage or "thumb" to the preceding joint. The legs are seven-jointed; the tarsi terminate in two small claws. The legs are clothed in the same manner as the body. There are two eyes upon each side of the cephalothorax, quite frequently borne on a distinct pedicel. Along the median line of the cephalothorax there is commonly a crista or dorsal groove similar to that of the Rhyncholophidæ. This crista is enlarged at the middle or posterior end into a triangular area, called the areola, in which are two pores from which arise bristles.

Doctor Oudemans terms these pseudo-stigmata and pseudostigmatic organs. The latter are sometimes clavate at or near tip. There is no proof that these are homologous with the organs of the same name in the Oribatidæ, although it is possible.

Sometimes these organs are present, although the crista is absent, and in one species there are two pairs of the organs. The function of these organs is entirely unknown. The genital aperture is situate between the hind coxæ; the anal opening is smaller than the genital and placed a little behind it.

The larvæ are six-legged mites and parasitic on various insects. They, with other larval forms, were formerly supposed to be adult and to constitute a distinct family under the name of Microphthiridæ. Three of the genera of that family, *Leptus*, *Oeypetus*, and *Atoma* (or *Astoma*), are now known to be larval Trombidiids. Some of these larvæ are, in certain localities, very numerous, and will attach themselves to man, causing intense itching, soreness, and even more serious complications. They have received the popular name of "red bug." In parts of the Southern States the "red bug" is often a source of great annoyance. They burrow beneath the skin and produce inflamed spots. It is an unnatural situation for the mites, and they soon die, but the waiting is not pleasant. They can be killed by anointing the affected spots with an ointment or salve containing sulphur. Some recommend sponging with a weak solution of car-

bolic acid (an ounce to a quart of water) after a soap bath. Allied species occur in most warm countries. In France, where they are often very troublesome, they are called "rouget" or "aotât," and are the

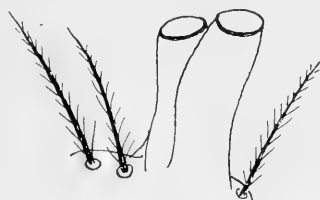


FIG. 44.—EYE OF TROMBIDIUM.

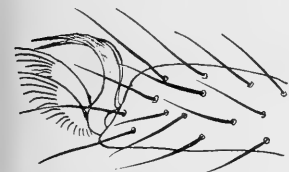


FIG. 45.—CLAWS OF TROMBIDIUM.



FIG. 46.—LEG I OF TROMBIDIUM.

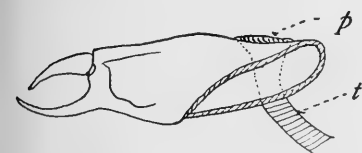


FIG. 47.—MANDIBLE OF TROMBIDIUM. *p*, TRACHEAL PORES; *t*, TRACHEA.

very troublesome, they are called "rouget" or "aotât," and are the

cause of the "erythema autumnale." In parts of Germany a severe infestation is known as "Stachelbeerkrankheit." In England and Scotland it is called the "harvest mite" and "gooseberry bug." In Mexico red bugs are known as "Tlalsahuate," in Japan as "Akamushi," and in

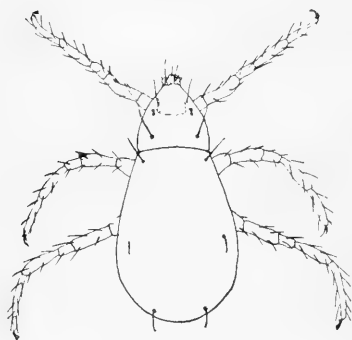


FIG. 48.—THE LARVA (LEPTUS) OF A TROMBIDIUM.

parts of the West Indies as the "bête-rouge." In all these countries they have at times been a serious annoyance to the peasantry and hindered or prevented the harvesting of certain crops. The female deposits the eggs in or upon the ground, sometimes as many as 400 together. They are usually brown and spherical, and were by some early writers considered to be fungi. The outer skin or chorion soon splits, dividing the egg into halves and exposing the pale vitelline membrane. This stage is the "deutovum" of Claparede.

The newly-hatched larva is circular or ovoid in outline, with three pairs of legs, each tipped with two or three prominent claws. After becoming attached to the insect the larva becomes elongate and swollen with food. When full fed it drops off, seeks shelter, and gradually changes in shape, but does not molt. The new parts are formed under the larval skin, which in a few weeks cracks and discloses the adult *Trombidium*.

The mature mite is not parasitic, but wanders about feeding on small insects, as plant-lice, young caterpillars, and one species, *T. locustarum* Riley, is known to destroy a great many grasshopper eggs. A French species has been found destroying the root-forms of the dreaded *Phylloxera*. The adult hibernates in sheltered places, or in the soil; the eggs are laid in the spring, and there appears to be but one brood a year. Only a few forms have been bred; the larvæ of one of them is common on the house fly in autumn, and a similar form occurs on mosquitoes.

Our species are all practically congeneric, but those forms that have two claws at the tip of the palpi fall in the genus *Microtrombidium* Haller. Kolenati's genera *Otonyssus* and *Peplonyssus*, parasitic on bats, appear to be larval Trombidions. The genus *Trombidium* contains a great many species—in the United States about ten. Several of our species are very common, and are often seen

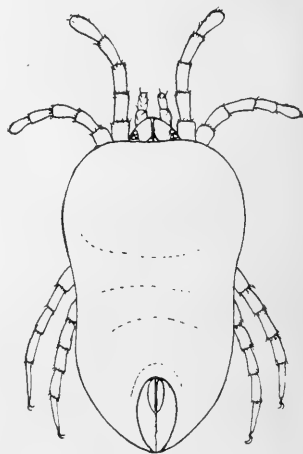


FIG. 49.—TROMBIDIUM LOCUSTARUM, MALE.

crawling about in early spring, their bright red color and silky vestiture attracting the attention of even the most casual observer. In the Southwest there is a very large, hairy species, *T. magnificum* Le Conte; it appears at times in enormous numbers, and in parts of Arizona is called "angelitos" by the Mexicans. Most of the species are of good size, some among the largest of the mites. In the Tropics there is a group

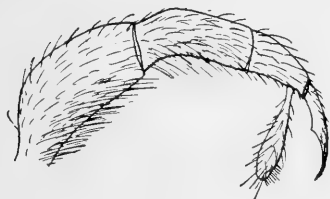


FIG. 50.—PALPUS OF *TROMBIDIUM GIGANTEUM*.



FIG. 51.—PALPUS OF *TROMBIDIUM MAGNIFICUM*.

of large species, of which *T. tinctorium* Linnaeus is perhaps the best known; it attains a length of about one-half inch, and occurs in the warmer parts of Africa. It was supposed to be used as a dye in olden times, but does not seem to be so used now. One of our species, *T. maritimum* Banks, lives under stones between tide marks on the seashore, and feeds sometimes on a maritime Coccid (*Ripersia maritima* Cockerell). Our most common species in the Eastern States is *T. sericeum* Say; it occurs in moist woodlands, and feeds upon small insects, frequently upon springtails.

The genus *Trombella* is founded on a curious South American species, and *Chyzeria* represents a form from New Guinea which has projections along the sides of the body.

Family CÆCULIDÆ.

A few mites of peculiar appearance, somewhat like *Nothrus* of the Oribatidæ, but structurally allied to *Trombidium*, constitute this family. They are rather large mites, of somewhat rectangular shape, and of a leathery texture, the legs are very rough, and the anterior pairs provided with a row of long spines. They terminate in two claws. The coxæ are arranged close to-

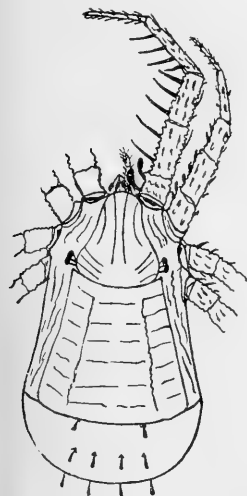


FIG. 52.—*CÆCULUS AMERICANUS*.

gether in a radiate fashion. The dorsum shows a transverse furrow, indicating the separation of cephalothorax and abdomen. The former is provided with a median shield, and from each posterior side arises

a pedicel bearing two eyes similar to those of *Trombidium*. The abdomen is provided with two or more shields, according to the species. The ventral openings are very large and close together, each closed by flaps or valves. The mouth-parts are small and obscure, but the palpus is stout, five-jointed, the first and third joints very small, the penultimate ending in a curved spine, the last forming a "thumb." The mandibles are stout and terminate in a curved claw. They are concealed in the large conical rostrum. The species are brown in color. Very little is known regarding their habits and nothing as to life history. They occur in moss, among fallen leaves, or in moist places. They move very slowly and feign death when disturbed. But one genus, *Ceculus*, is known. Several species occur sparingly in southern Europe and northern Africa. One, *Ceculus americanus* Banks, was discovered by Hubbard in southern California.

Family HYDRACHNIDÆ.

Since O. F. Müller described the Danish species in 1781, the water mites have attracted more attention and study than any other family of Acarina. A large number of important papers have been published,

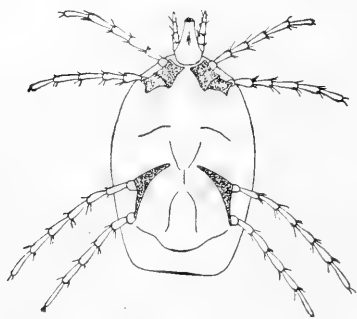


FIG. 53.—LIMNOCHARES; VENTER.

particularly on the European fauna, and a recent number of "Das Tierreich" (fascicule 13) is devoted to them. The body is commonly short, usually high, and sometimes nearly spherical. It is entire, there being no division into cephalothorax and abdomen. The legs arise close together on the anterior part

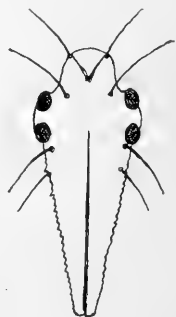


FIG. 54.—LIMNOCHARES;
EYES AND DORSAL
PLATE.

of the venter, and often in a radiate arrangement. They have one or two simple eyes each side; in some cases these are situate close to the median line. The tegument is often soft, but sometimes provided with dorsal shields or covered with a pitted cuirass. The mouth parts are often hidden under the anterior margin of the cephalothorax. The beak (rostrum or capitulum) is usually elongate pyriform, and the mandibles are two-jointed, with a claw-like terminal joint; sometimes they are elongated into needle-like piercing organs. The palpi (maxillary) are of four or five joints, the basal one often very small, the apical one sometimes folding against the penultimate. The palpi vary greatly in shape and are of great value in classification. The legs are usually of seven

joints, rather subequal in length, although the fourth pair is commonly the longest. The coxæ are often broad and entirely united to the venter and frequently to each other. The coxæ or epimera thus form coxal or epimeral plates—sometimes four, sometimes three, and in a few genera they are united into one plate. The tarsi often terminate broadly, and usually have two claws. They are provided with hairs and bristles. Sometimes there are rows of hairs for assistance in swimming; these are most numerous on the posterior legs. On the venter are the genital and anal openings; sometimes the former is very far back, nearly or quite on the posterior margin.

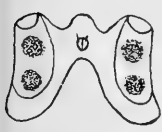


FIG. 56.—EYE-PLATE OF EYLAI.

There is usually a group of sucking disks each side of the genital aperture, the number and position of which are quite characteristic of each species. On the dorsal side of the rostrum (capitulum) are two spiracles that lead to the tracheæ; in some forms there are no tracheæ.

The adult mite lives free in the water as a rule, but in *Atax* they are parasitic in the gills of mollusks. The young are frequently parasitic on insects or mollusks. Many of the species are red or bluish-green in color; often they are prettily marked with yellow or black, and vary considerably in maculation. Hydrachnids are rather above the average size of mites, some species being fully 8 millimeters long and most of them over 1 millimeter.

There are frequently differences in structure between the sexes; in *Arrenurus* and some other genera the male has an elongated abdomen tipped with a median projection called the petiolus. In some forms the males have some of the joints of the legs especially modified. The female lays spherical eggs on water-plants, stones, or in the

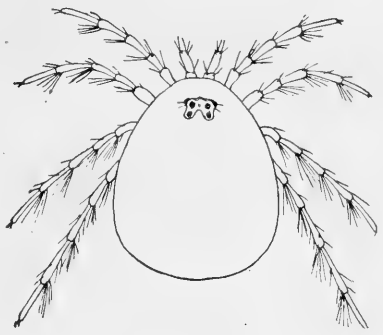


FIG. 55.—EYLAI SP.

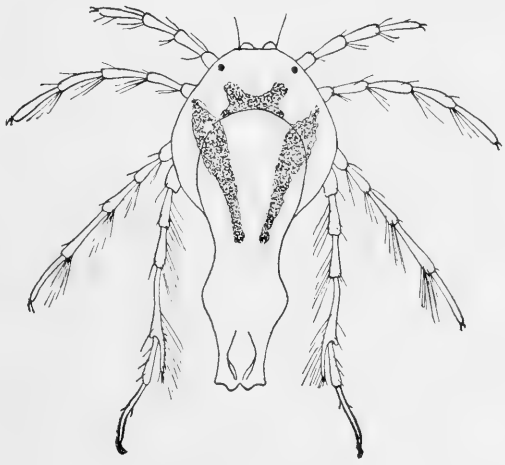


FIG. 57.—ARRENURUS SP., MALE.

mantle-folds of Lamellibranch mollusks. During the course of development a membrane is separated from the embryo while yet inclosed in the egg-shell; the egg in this condition is the deutovum. After the egg-shell is broken the embryo continues to develop within this



FIG. 58.—ARRENU-
RUS SP., PALPUS.

deutovum. The larva on hatching is six-legged, and in some cases is parasitic in the respiratory system of mollusks or attached to aquatic insects. Neumann has claimed that in one species of *Limnesia* the form hatching from the egg is eight-legged, and therefore a nymph, as in *Pteroptus*. Kramer has arranged the larvæ in three series, which he considers is the basis of classification. As a whole, the larvæ differ greatly from the adults and many were described as different creatures. Some were the basis of the genus *Achlysia*. The larva usually has very small mouth-parts; it fastens to an insect by means of hooks at the tip of the short, stout palpi, inserts its jaws and proceeds to feed. Gradually the body becomes swollen, the legs shrink, and the creature looks like an elliptical egg. The pupa is formed within this sac-like body, and from it in time issues the adult mite.

Nearly all Hydrachnidae live in fresh water, a few forms occur in brackish water, and several are known from the littoral zone of the sea. They are sometimes parasitic, as already noticed, but usually free, and feed on any small animals they can catch, such as small crustacea, infusoria, and minute insect larvæ. The water mites are found throughout the globe, but appear to be most numerous in temperate regions. Many species inhabit rapid streams and very cold water. About 60 genera and 600 species have been described. The species are often widely distributed and found amid very differing surroundings.



FIG. 60.—LARVA OF AN HYDRACHNA AT-
TACHED TO LEG OF AN INSECT; NYMPH
INSIDE.

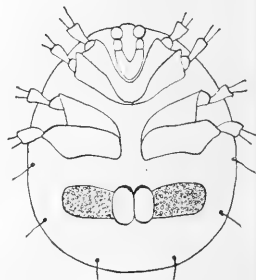


FIG. 59.—ARRENURUS SP., FE-
MALE FROM BELOW.

Various classifications have been made, one of which arranges them in 14 families. However, it may be better in this paper to use a less complex system. Some writers have kept the Hydrachnidae quite distinct from all other mites, but they are now generally recognized to be closely related to the Trombidiidae. Nordenskiöld believes

the family to have two separate origins, and therefore not natural.

In the following table are found several common European genera which are not yet recognized from this country, and doubtless other

European genera will also be found to occur in North America. A German, Doctor Koenike, published a valuable paper on some Canadian forms, and lately Dr. R. H. Wolcott, of Nebraska, has issued several excellent articles on our native species.

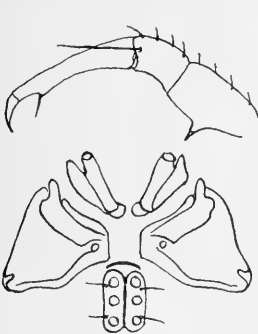


FIG. 61.—LIMNESIA SP., PALPUS AND COXAL PLATES.

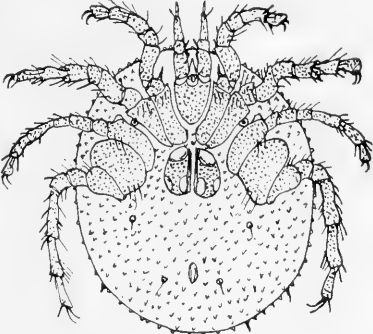


FIG. 62.—TYRELLIA CIRCULARIS.

1. Living in the sea	<i>Pontarachna, Nautarachna</i>
Living in fresh water	2
2. Eyes close together near the median line	3
Eyes widely separate on the sides	4
3. Hind legs far from front legs, and without swimming hairs; tips of tarsi obliquely truncate; body somewhat divided into cephalothorax and abdomen; in fact, the whole creature is trombidiform	(Limnocharinae) <i>Limnochares</i>
Hind legs not far from front legs; with swimming hairs; tarsi pointed; no indication of division of body	(Eylarinae) <i>Eylais</i>
4. Penultimate joint of palpus prolonged beyond base of last or with a tooth or spine-like projection near, or at tip	(Hydrachninae) 5
Penultimate joint of palpus not prolonged beyond base of last, nor ending in a spine	(Hygrobatinae) 10
5. Mandibles, one-jointed, needle-like	<i>Hydrachna</i>
Mandibles of two joints, with claw at end	6
6. Lateral eyes far apart	<i>Diplodontus</i>
Lateral eyes close together	7
7. Without swimming hairs to legs	8
With swimming hairs	9
8. With a median eye on front part	<i>Thyas</i>
Without median eye	<i>Parasus</i>
9. With a median eye on front part	<i>Hydryphantus</i>
Without median eye	<i>Tanaognathus</i>
10. Fifth joint of palpus forming a claw opposable to the apical part of the fourth joint; males frequently have the abdomen extended behind	11
Fifth joint of palpus not forming a claw opposable to the apical part of fourth joint	13
11. Capitulum or rostrum elongate, of two joints; palpi very small	<i>Krendowskia</i>
Capitulum short, entire	12
12. Dorsum with a furrow, following somewhat the outline of body; in male open behind	<i>Arrenurus</i>
Dorsum without furrow	<i>Steganaspis</i>
13. Epimera of both sexes united into one plate	14
Epimera (at least of female) not united into one plate	17

14. Fourth joint of palpus with a projection below	<i>Xystonotus</i>
Fourth joint of palpus without projection	15
15. Dorsum without a bowed furrow	<i>Lebertia</i>
Dorsum with a bowed furrow	16
16. Second joint of palpus with a projection below; genital aperture at tip of body	<i>Aturus</i>
Second joint of palpus without projection; genital aperture much before tip of body	<i>Mideopsis</i>
17. Fourth tarsus without claw; a long bristle at tip	<i>Limnesia</i>
Fourth tarsus with claw as others	18
18. Genital opening with lip each side nearly covering the disks; palpi with spine below on joint 2	<i>Sperchon</i>
Disks near genital opening fully exposed	19
19. Epimera of female in two groups	<i>Kanikea</i>
Epimera of female in three groups; genital opening usually with three disks each side	20
Epimera of female in four groups	21
20. Apical joints of leg I normal	<i>Hygrobates</i>
Fifth and sixth joints of leg I curved	<i>Atractides</i>
21. Genital opening with three disks each side	<i>Tyrrrellia</i>
Genital opening with more than three disks each side	22
22. Legs I and II with spirally ringed bristles	<i>Neumammia</i>
Legs without such bristles	23
23. Genital opening at tip of body	24
Genital opening much before the tip	25
24. Without swimming hairs on legs; fourth joint of palpus without three spurs below; genital area large	<i>Feltria</i>
With a few swimming hairs; fourth joint of palpus with three spurs, or papillae, below; genital area smaller	<i>Atax</i>
25. Hind epimera with a pointed projection below; palpi larger than leg I	<i>Najadicola</i>
Hind epimera without a projection; palpi smaller, and end in two or three small claws; the fourth joint has two papillae below	<i>Piona</i>

The genus *Limnochares* is practically an aquatic Trombidian; the body is of the same shape, and red in color. It can not swim, but creeps over the mud and plants under water. The young are parasitic on water-skaters (Gerridæ). Our species is very like the European.

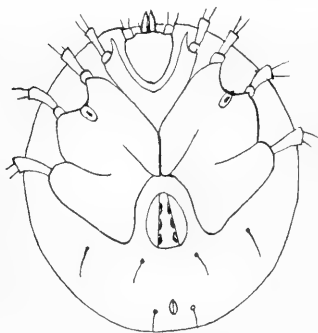


FIG. 63.—VENTER OF LEBERTIA.

We have three species of *Egylais*. They are distinguished by having four simple eyes situate close together on a plate near the median line. They are most frequently found in ponds. A larva of this genus has been found on mosquitoes. The genus *Thyas*, of which we have a few species, has no swimming hairs on the legs, and beside the lateral eyes there is a median eye in front. Several

species of *Arrenurus* have been described from North America, and doubtless many more occur. They are often green in color, and have a chitinous dorsum. The dorsum has a circular furrow in the male open behind.

The males have the body extended behind, and there is a small median petiolus. They live most commonly in lakes and ponds. *Krendowskia* and *Steganaspis* are each represented by one species.

In *Aturus* the epimeral plate covers nearly the entire ventral surface; one species is known from a small river in Canada. Of *Xystonotus* and *Mideopsis* but one species is known in each; the latter is also a common European water-mite.

The species of *Sperchon* are often found in cold and rapid mountain streams. Three species are known from Canada. They have the palpi enlarged at base, and the second joint bears a strong spur below. The sucking disks each side of the genital opening are nearly concealed by lateral flaps. The legs have no special swimming hairs.

Limnesia is a large genus; three species have been recorded from Canada, two of them European. They have a soft body; the hind legs are well provided with swimming hairs, and the fourth tarsus lacks the claws, but is provided with a bristle at tip. The palpi have the basal joints enlarged and often with a spur below. They usually occur in lakes.

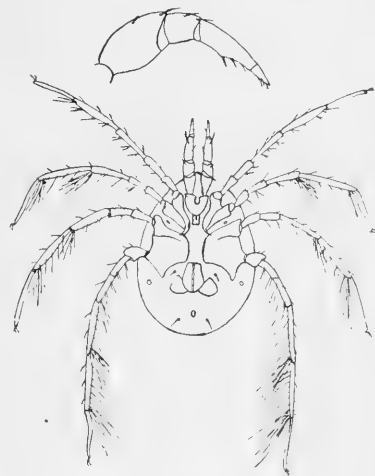


FIG. 64.—*PIONA* SP., AND PALPUS ABOVE.

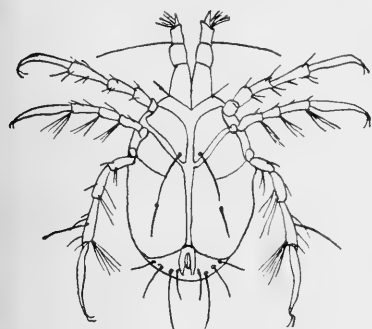


FIG. 65.—LARVA OF *PIONA*.

Koenikea is represented by one species widely distributed in the northern parts of our country. The species of *Hygrobatas* have soft bodies, the slender legs destitute of true swimming hairs, and the palpi have a spur or tooth below. There are three sucking disks each side of the genital orifice. Four species are known from Canada.

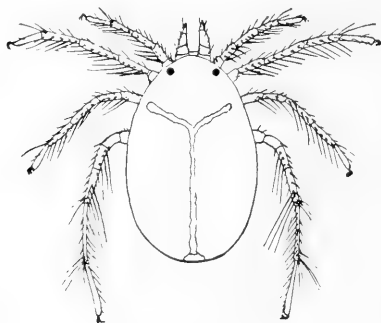
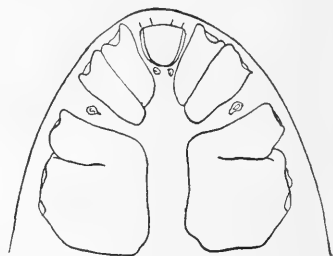
Atuw is one of the largest genera, and Doctor Wolcott has worked out some twelve species, and another has since been added from Texas. The genital opening is situate at the tip

of body, and the sucking disks each side are ten or more in number. The legs have swimming hairs and the first pair is thicker than usual. The palpi are enlarged at base, and the fourth joint bears three papillae or spurs below. Most of the species occur, for at least a time, in certain fresh-water mussels, particularly of the genera *Unio* and *Anodonta*.

They are found on the mantle-folds or gills of the mussel, and feed on the minute animals drawn in by the mussel. The late Doctor Haldeman described a number of species under the generic name of *Unionicola*.

The genus *Neumannia* is closely allied to *Atax*, but peculiar on account of the spirally ringed bristles on legs I and II.

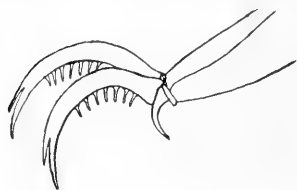
The genus *Piona* (*Curvipex*) is also a large genus, and about 19 species are now known in North America. They occur chiefly in lakes

FIG. 66.—*ATAX* SP.FIG. 67.—COXAL PLATES OF *ATAX*.

and ponds. The fourth joint of the palpus usually has two papillae beneath, and the legs are well provided with swimming hairs. The genital aperture is much in front of the hind margin, and each side of it are a great number of sucking disks, often of two sizes.

Family HALACARIDÆ.

This is a small family of marine mites. They have a leathery skin, frequently granulate or striate, but commonly destitute of bristles. Sometimes there are coriaceous plates or shields. The body usually shows the division into cephalothorax and abdomen, both above and below. The rostrum is often quite prominent, sometimes as large as in the Bdellidæ. The cephalothorax usually has three eye-spots, one on the middle in front. The palpi are three or four-jointed, the last article sharp-pointed at tip. The mandibles are rather promi-

FIG. 68.—CLAWS OF *HALACARUS*.

nent, and end in a single straight, or recurved claw. The legs are moderately long, rather widely separate at base, lateral or sub-lateral in origin, and end in two claws. They bear a few scattered bristles. The genital opening is quite large and far back; the anus is small and at the tip of abdomen. These mites have no tracheæ, but do not appear to be related to other atracheate Acarians, but rather to the Bdellidæ and Oribatidæ. It is, perhaps, not a natural family, but derived from several groups. The Halacaridæ are found crawling slowly over algæ,

frequently in shallow water, but some have been dredged at considerable depths. The adults are free, and feed on diatoms and other minute vegetation. The young of some forms feed on the eggs of Copepods, while others are attached to various animals. One is known to occur on a *Chiton*. They are from one to two millimeters in length, and their colors depend largely on the nature of their food. The young have the general appearance of the adults, and nymphs sometimes possess rudimentary genital organs. The legs of the nymphs have each one less joint than in the adults. They have been

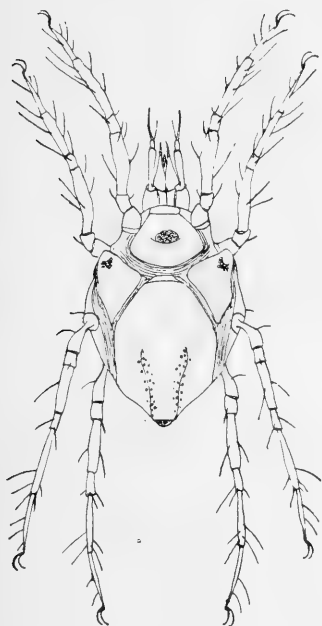


FIG. 69.—HALACARUS SP.

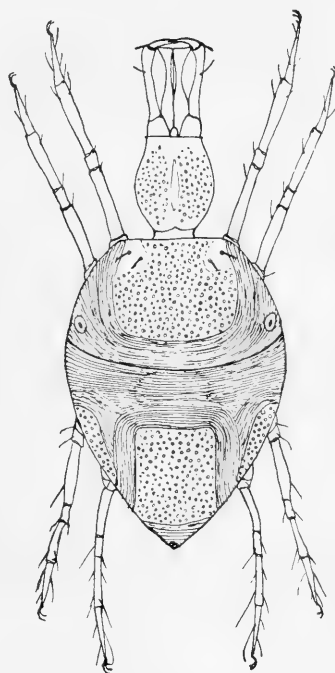


FIG. 70.—SCAPTOGNATHUS SP. (AFTER TROUESSART).

found in nearly all seas, and about seventy species are now known. The forms along the coasts of North America have not been studied. The principal genera may be tabulated, as below.

- | | |
|--------------------------------------------------------|-------------------------|
| 1. Rostrum elongate and constricted at base..... | 2. |
| Rostrum not constricted at base..... | 3. |
| 2. Palpi apparently three-jointed, separate..... | <i>Scaptognathus</i> . |
| Palpi, four-jointed, connate at base..... | <i>Trouessartella</i> . |
| 3. Rostrum elongate, palpi separated at base..... | 5. |
| Rostrum very short, triangular..... | 4. |
| 4. Palpi separated at base..... | <i>Rhombognathus</i> . |
| Palpi connate at base..... | <i>Simognathus</i> . |
| 5. Palpi apparently but three-jointed..... | <i>Coloboceras</i> . |
| Palpi plainly four-jointed..... | 6. |
| 6. Third joint of palpus nearly as long as fourth..... | <i>Agave</i> . |
| Third joint of palpus much shorter than fourth..... | <i>Halacarus</i> . |

Most of the species come from the French coasts or the Atlantic Ocean: one was described from fresh water. A few are from other regions, and doubtless, as they are more collected, the family will be of considerable size. *Halacarus*, the largest genus, contains about fifty species, several of which bear some resemblance to *Scutoreptes* in the Oribatidæ. Most of them are marked with brown, reddish, or black. Dr. E. Trouessart, of Paris, has published very largely upon them. Packard described, under the name of *Thalassarachna verrilli*, a species of *Halacarus* from the coast of Maine; it was found on algae.

Superfamily IXODOIDEA.

The members of this group, commonly known as ticks, are of all Acarians the most familiar to ordinary people. Their body is covered by a tough, leathery skin, which in the female is capable of great extension. The ticks (before distention) are of a somewhat triangular

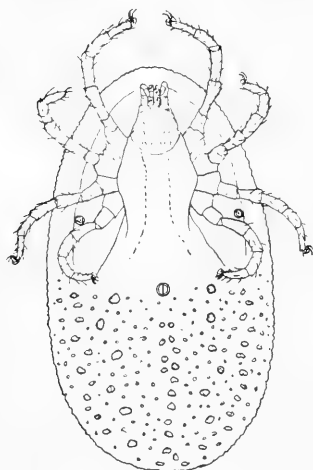


FIG. 71.—*ARGAS MINIATUS*, FROM BELOW.

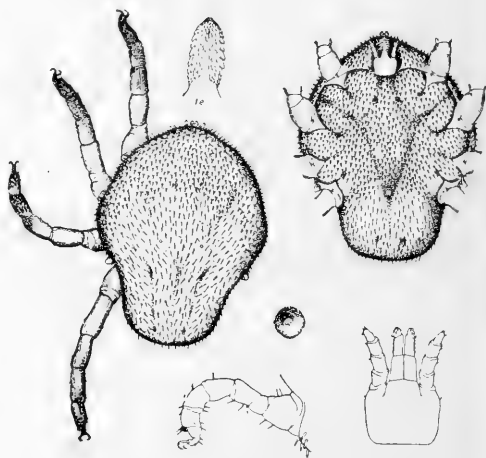


FIG. 72.—*ORNITHODOROS MEGNINI*; NYMPHAL FORM, AND DETAILS (MARX).

outline, moderately flat, with prominent, slender legs and a beak-like rostrum in front. On the anterior part of the dorsum there is a corneous piece or shield that may represent the cephalothorax. This is known as the scutum, and is absent in the family Argasidæ. With the male this scutum covers the greater part of the dorsum. Articulated to the anterior margin of the scutum, usually within an emargination, is a small, transverse piece, the capitulum or head. The posterior corners of the capitulum project backward in spines. In the female ticks there are on the dorsum of the capitulum two pitted areas, known as the porose areas. The capitulum bears the palpi on each side and the mandibular sheaths. The latter include the mandibles

and the hypostome. These are sometimes called the proboscis, haustellum, or rostrum. The hypostome is a central piece, bearing many recurved teeth or denticles. The number of rows of these denticles is used as a specific character in classification. At the tips of the mandibles are two or three processes known as the apophyses. They also have been used in classification, but are variable. The palpi are always very short and stout and composed of four articles, not, however, very distinctly. Some species have eyes situate one at each lateral angle of the scutum. The posterior margin of the body, especially of the male, is usually somewhat lobate, these lobes being known as the posterior marginal festoons. The stigmata or spiracles are above and usually behind the coxæ IV. Each is surrounded by a reticulated or pitted plate of varying outline, and called the peritreme or stigmal plate. It is often of large size. Upon the venter there are several furrows characteristic in position and of value in classification. The anal opening is a small, circular hole some distance behind the coxæ IV; the genital pore is situate on the front of the sternal area, slightly behind the mouth-orifice. The legs arise close together, but in the distended females the coxæ become quite widely separated. There are six joints in the leg—coxa, trochanter, femur, tibia, protarsus or metatarsus, and tarsus; the latter is sometimes divided; while the femur often presents a basal distinct portion, which may be the trochantin. Upon the tarsus of the first pair of legs is a depressed circular area, supposed to be an organ of hearing; it is known as Haller's organ, in honor of its discoverer. The tarsus terminates in a short stalk that bears the two claws and the pulvillus or caruncle. The body of a tick is usually dull colored, but some forms are mottled with brown and yellowish or reddish.

Ticks are parasitic on mammals, birds, and reptiles. But at times they may leave their host, and are not confined to one host, although some species show a preference. Most of them do but little damage to their hosts while sucking blood, but several closely allied species belonging to the genus *Boophilus* transmit an organism, the *Pyrosoma bigemminum*, that causes a disease in cattle known as Texas fever. Southern cattle fever, red-water, heart-water, etc. As a result of her bloodthirsty nature the female tick becomes enormously distended.

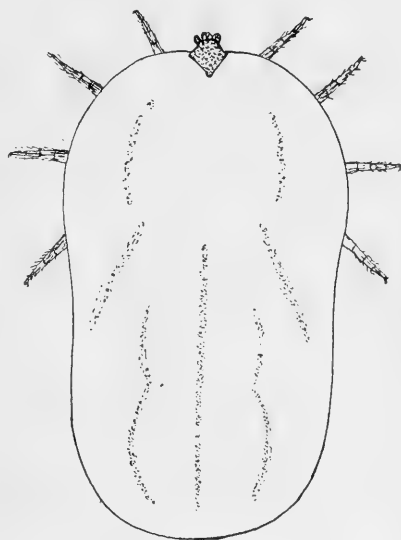


FIG. 73.—*BOOPHILUS ANNULATUS*, FEMALE.

and is then in a mature condition. The life history of ticks has been described by Curtis, Morgan, Lounsbury, and others. Ticks pair during parasitism, the male remaining beneath the female for some days, the latter finally dropping to the ground to deposit her eggs. These may be as many as 10,000 to 20,000, and issue as elongate masses in front of the tick. During the operation the head is with-

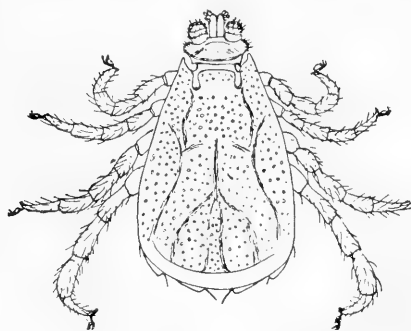


FIG. 74.—*BOOPHILUS ANNULATUS*, MALE.

drawn into the body, so that the neck behind the capitulum is close to the genital pore. As the eggs issue they are coated with a viscous substance secreted from glands in the neck. These eggs lay upon the surface of the soil, or just beneath it, and the larvae hatch in a few days. The young ticks, known as "seed ticks," ascend the nearest support of grass or herb, and patiently await the coming of some animal. Delay and disappointment must often end in starvation and death. However, many secure an attachment to some animal, often, perhaps, not the desired one. In a few days the young tick is rapidly distended by the blood it has sucked from its host, and drops to the ground. Here it seeks a cavity or hiding place, and rests. In three or four days the skin splits and from it the nymph issues, and begins the same waiting process that it experienced as a larva. As it has already had a good meal of blood, it can wait for many days without fear of death. When it secures hold of an animal, the abdomen distends as before, and it soon falls off again to hide and molt. After this molt the tick is adult; it waits again for a host, and when secured starts the life-cycle anew. The Texas cattle-tick and its allies do not drop off for molting, but cast the skin while upon the host. They drop to the ground, however, for the purpose of laying eggs, as the other ticks.

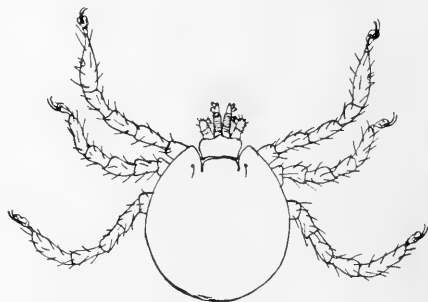


FIG. 75.—LARVA OF *BOOPHILUS ANNULATUS*.

In the true ticks there is a considerable difference in the abdomen of males and females. In the latter the dorsal shield does not cover the entire abdomen, while in the male this shield extends to the tip. The males of some species have spines upon some of the coxæ, and sometimes an extra pair of shields on the venter.

The internal anatomy of the Ixodidæ has been examined by Heller (1848) and later by Pagenstecher (1861). The pharynx soon contracts into a slender œsophagus, which, as usual, passes through the "brain" and into the stomach. The latter is not very large, but has several diverticula or cæca, some in front, and usually four large ones behind and one longer on each side. The color of the food in the cæca often shows through the integument, so that the same species at different times exhibits different markings on the body.

Upon this basis the earlier authors often described one species under several names. The intestine is short and straight, enlarging somewhat before the anus. The breathing apertures or spiracles open into a large sac, which soon divides into a host of small tracheæ that spread out in the body cavity. In the anterior part of the body are two large, botryoidal salivary glands, opening through a duct each side of the mouth. The female genital organs consist of two elongate ovaries, each with a slender oviduct, which unite shortly before the vulva. The male organs consist of the two slender testes, each emptying into a large median sac, from which a slender duct leads to the opening.

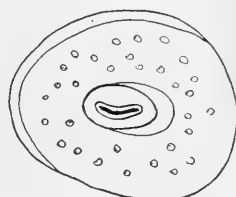


FIG. 76.—STIGMAL PLATE OF *BOOPHILUS ANNULATUS*.

The Ixodoidea are readily divided into two families.

No scutum; no ventral shield; mouth-parts of adult not prominent from above; no pulvillus to tarsus in adults; stigmatal plate between coxæ III and IV...*Argasidæ*
 Scutum present; sometimes ventral shields; mouth-parts of adult prominent from above; pulvillus to tarsus of both adults and young; stigmatal plate behind coxæ IV.....*Ixodidæ*

The Argasidæ, containing but few genera, are in some ways intermediate between the true ticks (Ixodidæ) and the Dermanyssidæ. The skin is usually covered with granulations or deeply pitted and the head and mouth-parts are hidden beneath the anterior part of the body. They are nocturnal in habit and feed on the blood of mammals (including man) and birds. Unlike the true ticks, the females of this family do not become so greatly distended with blood. There are two genera in our fauna.

Capitulum at least its length from the anterior margin.....*Argas*
 Capitulum under a beak-like projection, close to anterior margin.....*Ornithodoros*

It is to the genus *Argas* that the famous Miana Bug of Persia belongs (*A. persicus*). It lives in houses, and its puncture was declared by the early travelers in those regions to produce startling results; convulsions, delirium, and even death following its attack. Specimens kept in Europe for experiment have failed to produce these dire consequences, but there is such a wealth of testimony as to the dangerous effect of the bite in Persia that possibly in that country the Miana Bug may at times carry the germs of some disease. The European

species, *Argas reflexus*, commonly infests pigeons, but has been known to attack man, not however with serious results. Our species, the "chicken tick," *Argas miniata* Koch (*americana* Packard) is not uncommon in the southern parts of the United States from Texas to California, and often does a great deal of injury to poultry. Chickens, badly infested, droop, refuse to eat, in a few days drop down, and finally die. It is of a dull reddish color, and the body granulate. The eggs are laid in masses of 30 to 100 and deposited in cracks of the chicken house. Perhaps the best remedy is to spray the inside of the chicken house with kerosene or benzine, then whitewash or dust with carbolated lime, and finally daub the ends of the roosts with coal tar. Isolating the roosts, by suspending them on stout wire, or by placing a barrier of cotton-waste soaked in oil around each end, will also be helpful.



FIG. 77.—CLAWS OF BOOPHILUS ANNULATUS.

It is now claimed that the chicken-tick in Brazil transmits the blood-parasite of a disease fatal to fowls. A similar species (*A. sanchezi* Dugès) is found in houses in New Mexico and Arizona and is there called the "adobe tick."

In the allied genus, *Ornithodoros*, we have two species, both known to attack man. *O. turicata* Dugès is the most dangerous. The Mexicans call it "turicata." In southern California they are known as "pajahuillos" to the cattle herders. Their bite will cause large swellings that remain for some days, and are very painful. The other species, *O. megnini*

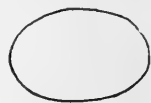


FIG. 78.—EGG OF BOOPHILUS ANNULATUS.

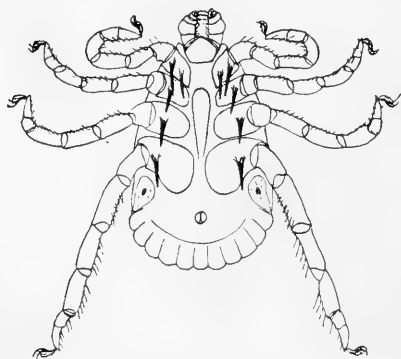


FIG. 79.—DERMACENTOR VARIABILIS, MALE FROM BELOW.

Dugès, is a serious pest to cattle and of much more common occurrence. It infests the ears of horses, cattle, sheep, and sometimes man, and has been called the "spinose ear tick." The nymphal stage is quite unlike the adult tick and was figured by Marx as *Rhynchoprion spinosum*. It is of a brown or blackish color, and in the nymphal stage is clothed with many stout spines. It has been known to cause death in cattle.

They can usually be removed by an application of linseed or olive oil. Like the preceding it is a Mexican species, which occurs only in the southern parts of our country, but is sometimes found as far north as Nebraska. The adult is known to Mexicans as the "garrapata," and the young are called "pinolias."

The Moubata bug, *O. saviignii*, is an African species whose puncture is reported to produce effects almost as dangerous as those ascribed to the Miana bug. It attacks both man and beast, sometimes occurring in houses. The pain of the puncture is not felt until several hours after it is inflicted, but gradually the spot becomes inflamed and irritable.

The Ixodidæ, or true ticks, are represented by a large number of species in tropical countries, but in the temperate regions they are much less common. However, there are about twenty-five species in the United States, and one of these, the Texas cattle tick, is a pest of prime importance. Our ticks are arranged in about seven genera, which may be tabulated as follows:

1. Palpi short, not or only slightly longer than broad; capitulum short	2
Palpi plainly longer than broad; capitulum longer	5
2. Dorsal surface of capitulum hexagonal, the sides projecting in angles; male with anal plates	3
Dorsal surface of capitulum rectangular, sides straight; male without anal plates. 4	
3. Second and third palpal joints extend laterally into sharp points; stigmata nearly circular	<i>Boophilus</i>
Second and third palpal joints even; stigmata comma-shaped	<i>Rhipicephalus</i>
4. Eyes present; external border of palpi straight; coxæ I bidentate	<i>Dermacentor</i>
Eyes absent; external border of palpi uneven; coxæ I not bidentate	<i>Hæmaphysalis</i>
5. Anal groove surrounds anus anteriorly and opens posteriorly; eyes absent; stigmal plate nearly circular	<i>Ixodes</i>
Anal groove surrounds anus posteriorly and opens anteriorly; eyes present; stigmal plate reniform	6
6. Anal plates absent	<i>Amblyomma</i>
Anal plates present in male	<i>Hyalomma</i>

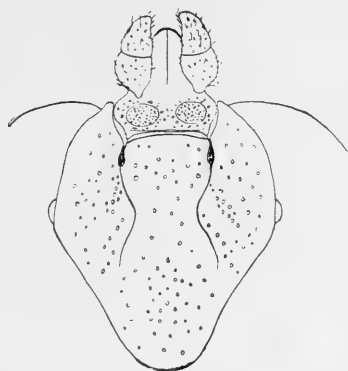


FIG. 80.—DERMACENTOR VARIABILIS,
SHIELD OF FEMALE.

Our one species of *Boophilus* (*B. annulatus* Say) (*bovis* Riley) is the distributor of Texas fever, a disease of cattle that causes enormous losses in the South, particularly in cattle imported there from the North. The southern cattle tick is found only in the Southern States and the Government maintains a quarantine line where cattle brought North may be cleansed of their ticks. The female tick is of a dark, dull brown color, with reddish scutum and legs; the male is reddish brown, the legs paler at articulations. The cause of Texas fever is a minute Protozoan parasite, *Pyrosoma bigemminum*. This is taken up with the blood by the *Boophilus*, which then inoculates each animal that it attacks. And even the young that have not infested any animal may produce the disease. The young ticks, called "seed ticks," are born on the ground; they climb upon grasses or bushes, and await the coming of cattle. Each attaches itself at the first opportunity, and begins to draw blood. In about a week it molts, remaining on the

host during this period. The male increases but little in size, but the female becomes enormously swollen and in about a month she is ready to drop off and deposit eggs.

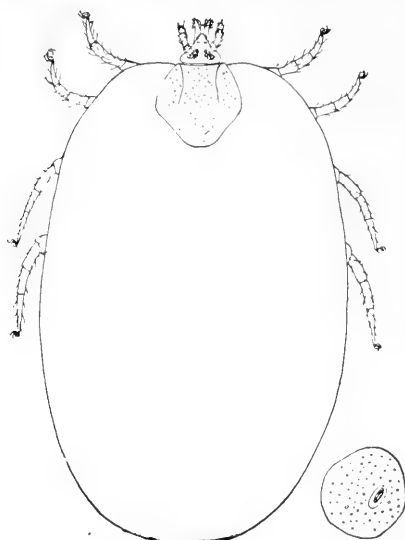


FIG. 81.—*IXODES CRUCIARIUS*, FEMALE, AND STIGMATAL PLATE.

Once in the blood of cattle the parasite destroys the red blood corpuscles, and causes a thinness of blood, the hæmaglobin of which appears in the urine. After death the spleen and liver are found to be greatly enlarged. The most promising preventive seems to be the removal of cattle from pasture for one year. This pasture disinfection may be hastened by cultivation for one year, or grazing it to sheep. It has been noticed that southern cattle may become immune, and with this hint a method of vaccination was devised for treating northern cattle when taken South.

There are several other species of ticks often found on cattle, but

none are known to carry the parasite of Texas fever.

Of *Dermacentor* there are three or four species in this country, all with the scutum more or less variegated with white and brown. The most common one is the "dog tick," *Dermacentor variabilis* Say, and is our most widely distributed species. It is found on cattle, dogs, horses, rabbits, and sometimes on man. On the latter it causes no serious consequences, but is a source of much irritation. They are so tightly attached that it is often impossible to remove them without either leaving the head in the flesh or else tearing out a piece of the skin. The other species are similar to the dog tick, but are less common. One occurs on the moose, and others on cattle, deer, and sheep.

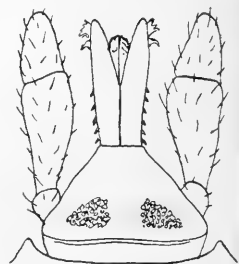


FIG. 82.—HEAD OF *IXODES*.

D. reticulatus Linnaeus, a European species, is perhaps more frequent in California than *D. variabilis*.

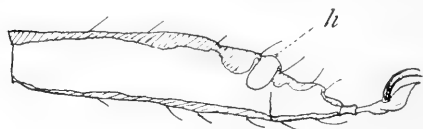


FIG. 83.—LEG I OF *IXODES*; SECTION THROUGH TARSUS, *h* HALLER'S ORGAN.

In the genus *Hæmaphysalis* (formerly *Rhipistoma*) we have one or two species that occur on rabbits and other small mammals.

In *Ixodes* there are several species; one is a European species, *I. ricinus* Linnaeus, that occurs occasionally on cattle. In Scotland this species often attacks sheep, and appears to distribute the germs of a

disease similar to Texas fever, that is known by the name of "loup-
ing-ill" or "trembling." The parasite is at present unknown. The
loss to Scottish herders is sometimes very heavy. It is said that sheep
in moist meadows are not as subject to ticks as those in drier pastures.
A pale yellowish or almost white species, with a brighter yellow scu-
tum, *I. cruciarius* Fitch, occurs on squirrels, gophers, rabbits, etc. In
Florida a reddish species, *I. scapularis* Say, is common.

Of *Amblyomma* there are a number of species, particularly in the
Tropics. *A. americana* Koch is often found on cattle, and is called the
"lone-star tick" on account of a prominent yellowish spot on the scutum.
On some species the markings become intricate; a series of yellow and
brown sinuate stripes variously interlaced. One of these, *A. crenata*
Say (*maculata* Koch) is very common in the Southern States, attacking
almost any mammal, including man. One large species, *A. tuberculata*

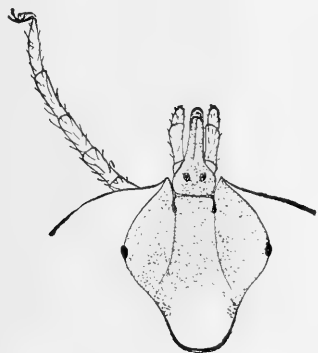


FIG. 84.—*AMBLYOMMA AMERICANA*,
SHIELD OF FEMALE.

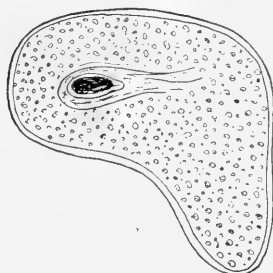


FIG. 85.—*AMBLYOMMA AMERI-*
CANA, STIGMAL PLATE.

Marx occurs on the Floridan gopher. The exotic genus *Ophiodes*
infests snakes; the various species are handsomely marked with brown,
red, and yellow. The genus *Hæmalastor* occurs on bats in Europe.

It has lately been shown that a South African tick, *Hæmaphysalis*
leachi Audouin, is the carrier of a blood-parasite that causes malignant
jaundice, or distemper, in dogs in South Africa. The young stages
do not communicate the disease, but if an adult tick feeds on infectious
blood, her descendants, when adult, may transmit the disease.

Superfamily GAMASOIDEA.

The Gamasid mites are among those best known to collectors of
insects, since many species are very common, and others spend part
of their life attached to beetles and other insects. Typically these
mites have a hard coriaceous integument, but there are many excep-
tions to this rule. They are quite flat, broad, and with rather short
legs. They have no eyes, but the sense of touch is very highly devel-
oped through many hairs on legs and body. Some species are slow
in movements, and are apt to feign death when disturbed, but others

can run with considerable rapidity. The mouth-parts, in many species, may be completely withdrawn into the body of the mite. The mandibles are normally chelate, and the fingers toothed. Sometimes they are greatly elongate and styliform, so fitted for piercing; in a few

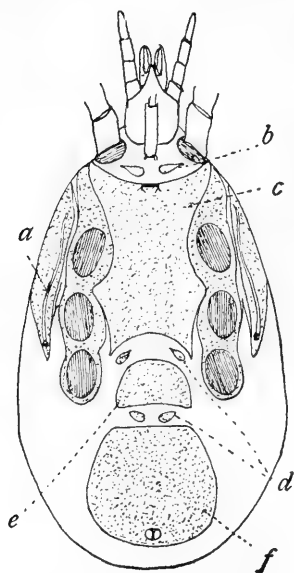


FIG. 86.—VENTER OF GAMASUS. *a*, PERITREME; *b*, JUGULARIA; *c*, STERNAL PLATE; *d*, METAPODIA; *e*, GENITAL PLATE; *f*, ANAL PLATE.

cases the movable finger is lacking. In many species there is a projection or appendage arising near the base of the fingers known sometimes as the "spur," sometimes as the "flagellum." Beneath the mandibles is a large piece, the hypostoma. It is bifid, and each side ends in an elongate corneous point. Between the two corneous points is a long fleshy part, the lingula. The palpi are prominent and usually five-jointed. Above the mouth there is in many forms a thin plate, often toothed, known as the epistoma. In the Uropodidae, the palpi are scarcely visible, as the body projects so much in front. The legs are of moderate length, usually slender, and arise close together, in a row each side. In the Uropodidae the anterior pair is separated from the others and their coxæ are nearly contiguous. The body is commonly provided with coriaceous plates or shields, the position and shape of which are characteristic

of each species. These plates sometimes nearly cover the entire body. Their position and names may be observed from the accompanying illustrations. There are some small shields or pieces which are often of importance; a pair just behind the fourth coxæ are called the "metapodia;" a pair just behind coxæ I are known as the "jugularia," and a pair behind sternal plate, the "metasternalia." There are frequently differences between the sexes in the arrangement of the plates, and in the males of many species the ventral plates are mostly coalesced. The female genital opening is commonly under the anterior margin of a plate (the genital) which ends near the coxæ of the third legs. The male genital aperture is usually at the anterior margin of the sternal plate, only a short distance back of the mouth. In some groups, notably the Uropodidae, the genital aperture of the

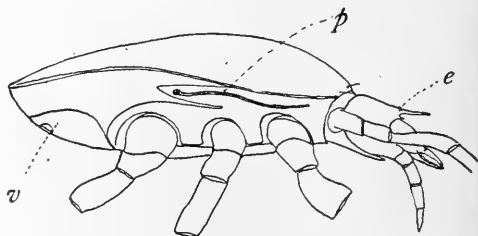


FIG. 87.—SIDE VIEW OF A GAMASUS. *e*, EPISTOME; *p*, PERITREME; *v*, ANAL PLATE.

male, or of both sexes, is situate in the middle of the sternal plate. The anal opening is small and placed near the tip of the venter; it is often surrounded by a plate. There is a spiracle or breathing pore on each side of the body, above and slightly in front of the fourth coxa. It is surrounded by a chitinous ring, the peritreme, which usually extends forward for a long distance, often in a slightly sinuous line. The legs are of six joints—coxa, trochanter, femur, patella, and tibia, of subequal length, and a long tapering tarsus. In some species there are indications of a division of the tarsus. The tarsi terminate in two claws, and sometimes a sucker or ambulacrum. In several forms the anterior legs are destitute of claws, and seem to act more as antennæ. In many species the males have the second pair of legs enlarged and provided with teeth and projections, and sometimes the hind legs are also armed. These legs are used to hold the female during pairing.

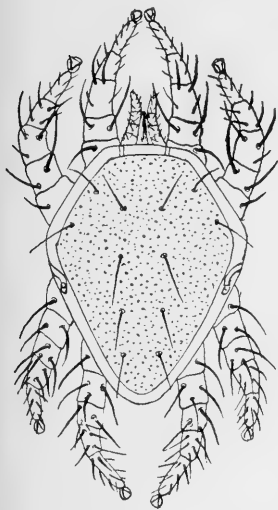


FIG. 88.—PTEROPTUS AMERICANUS.

The internal anatomy of the Gamasidæ has been studied perhaps more than that of any other family. It differs in various ways from what may be called the typical acarid anatomy. Kramer has shown that in some forms there is a tendinous framework in the middle of the body, a sort of internal skeleton, to which are attached many of the larger muscles. The male sexual organs are usually on the common plan. There is, however, a large accessory gland lying between and beneath the vas deferens. There is no intromittent organ; and sometimes there are two testes. The female generative organs usually differ much from that in other families. Often there is a semiglobular or botryoidal ovary, opening into one (sometimes two) oviducts, that lead to the vagina; above the vagina is a domed chamber, the spermatheca. At times there are two small glands that open into the vagina. In many forms there is no spermatheca, in which case Michael has discovered the existence of other organs of a most curious nature. Attached to the top of the ovary are two rather clavate arms, known as the lyrate organs; and above is a large sac, the *sacculus femineus*, connected at one end to the ovary and at the other by two annulate tubes to the acetabula of the coxæ of the third pair of legs. After

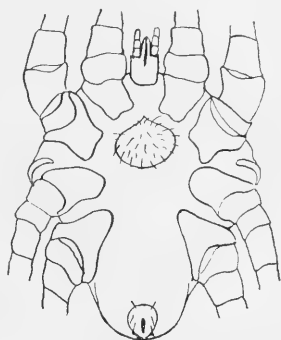


FIG. 89.—VENTER OF PTEROPTUS.

the eggs are all deposited the sacculus becomes very small. Sometimes it is wanting, but the annulate tubes are present and connect direct to the ovary. The significance of these organs is not fully known, but the sacculus contains spermatocysts which are supposed to reach it through the annulate tubes.

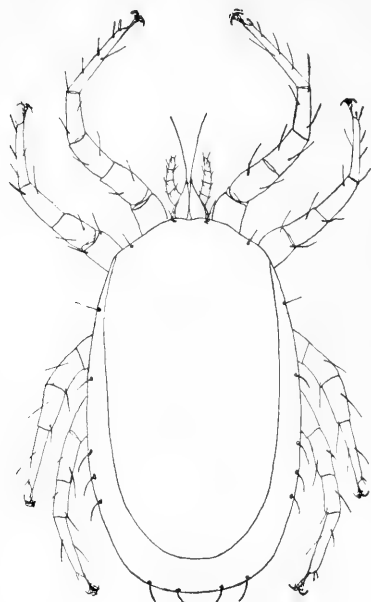


FIG. 90.—*DERMANYSSUS GALLINÆ*.

Some, if not all, of the Gamasidæ have a most remarkable method of coition, which Michael has discovered and described in detail. The male, which is commonly a little smaller than the female, clasps the latter by the legs of one side and crawls under her. His abdomen extends back beyond that of the female, and he grasps her by his legs. Then a clear sac emerges from the genital aperture of the male, gradually enlarging until it is of full size and shape, which is constant for each species. Usually this sac or bubble is flask-shaped, with a long neck. It incloses the spermatozoa floating in a clear viscid liquid (sometimes within spermatocysts). The male clasps this bubble with his mandibles, which are often modified apparently for such purpose. The male then applies the small end of the bubble to the vulva of the female, often inserting his mandibles for some distance. Here the small end of the bubble bursts and the liquid and spermatozoa are discharged into the spermatheca of the female. The bubble is rather firm, and when empty does not collapse, but shrinks somewhat. After the male leaves the female he proceeds to clean his mandibles. In those species in which the female has no spermatheca, but has annulate tubes connecting to the acetabula of the third pair of legs, it is probable that the bubble is applied to these apertures, and not to the vulva. The spermatozoa thus passing into the sacculus femineus, from which they may pass into the ovary as occasion demands. In

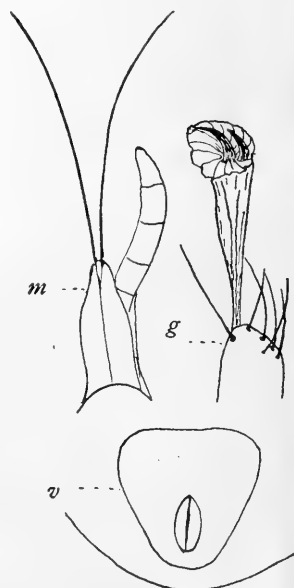


FIG. 91.—*DERMANYSSUS GALLINÆ*. *g*, CARONCLE; *m*, BEAK; *v*, ANAL PLATE.

the male of one species there is a hole in the jaw, through which the bubble is blown, part hanging down on either side.

Trouessart has shown that in *Railletia* there is a true parthenogenesis; agamic generations are found in spring and summer, the male appearing only in the autumn or winter. He also found that this form has no nymph, the larva changing into the adult female.

Gamasids deposit eggs which hatch into pale, soft-skinned, six-legged larvæ, often very different

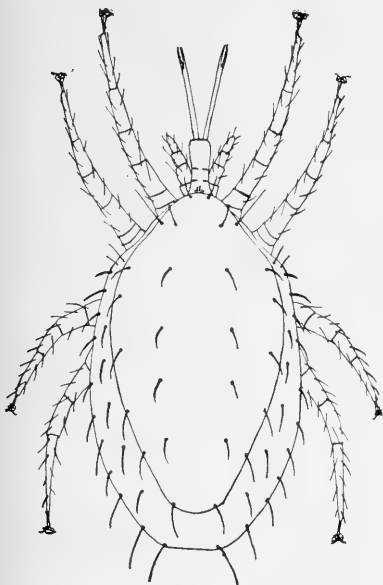


FIG. 92.—LIPONYSSUS AMERICANUS.



FIG. 93.—LIPONYSSUS; ANAL PLATE AND MANDIBLE.

from the adult. There is a remarkable exception in *Pteroptus* and allied genera of the Dermanyssidæ; the young of these mites hatch with eight legs. In time the larva molts into an eight-legged nymph.

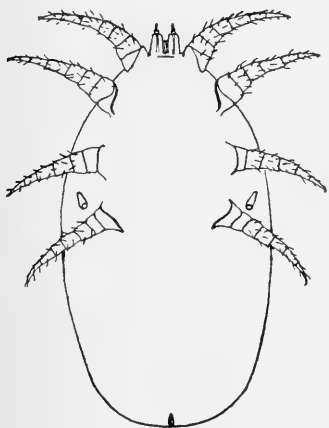


FIG. 94.—PNEUMONYSSUS SIMICOLA, FROM BELOW.

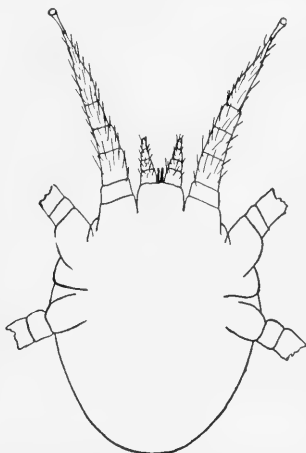


FIG. 95.—LARVA OF PNEUMONYSSUS SIMICOLA.

In this stage they have shields, the dorsal often transversely divided. The nymphal stage is often the longest and most active period of their

life—the stage of growth and development. After one or two molts in this stage some forms approximate closely in appearance to the adult condition. Hence there are names for the various portions of the nymphal mite, the earlier part being the protonymph, then the deutonymph, and sometimes a tritonymph. These terms are applied in the true Gamasidæ. In the nymphal stage some Gamasids are attached to various insects for the purpose of transportation. In fact, some genera (as *Uropoda*) are chiefly known to us in this migratorial nymphal condition. Various writers have claimed that the mite was a parasite of the insect, but such is not the case. The insect is used only as a means of transportation. In some cases the mite is attached to the insect by an anal pedicel formed of excretions. Such a one is known as a “nympha pedunculata.” In some cases the nymph

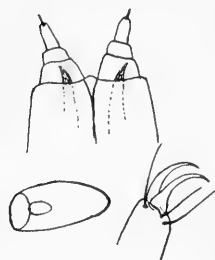


FIG. 96.—PNEUMONYSSUS;
BEAK, CLAWS, AND STIG-
MAL PLATE.

may pair and produce eggs; these are called “nympha pedogenica.” The nymph from the larva is often more like the larva in many ways than like the adult. This first nymphal stage is called “nympha heteromorpha.” The nymph after molting may look like the adult; this second nymph is the “nympha homeomorpha.” These latter two terms are applied only in the Uropodidæ. Some Gamasids live in decaying substances,

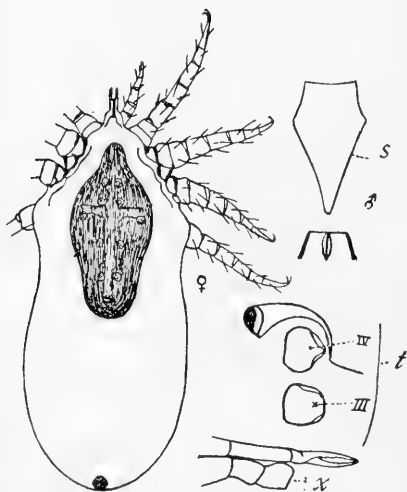


FIG. 97.—HALARACHNE AMERICANA. ♂, STERNUM
OF MALE; *t*, STIGMATA AND COXÆ; *x*, MANDIBLE.

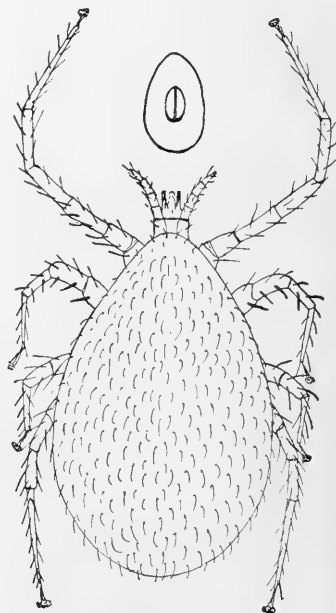


FIG. 98.—HÆMOGAMASUS AMERICANUS,
AND ANAL PLATE.

either animal or vegetable. It has been shown that certain Uropodidæ live on minute plants, bacteria, and small fungi. Most species prey on small insects, Thysanurans, other mites, as Tyroglyphidæ and Eriophyidæ, and occasionally they will eat one another.

There are a few parasitic forms; the entire family Dermanyssidae is parasitic on birds, bats, rodents, etc. Two genera of the true Gamasidae are parasitic — *Hæmogamasus* on moles, and *Raillietia* in the ears of various animals. A great many occur among decaying fallen leaves. A num-

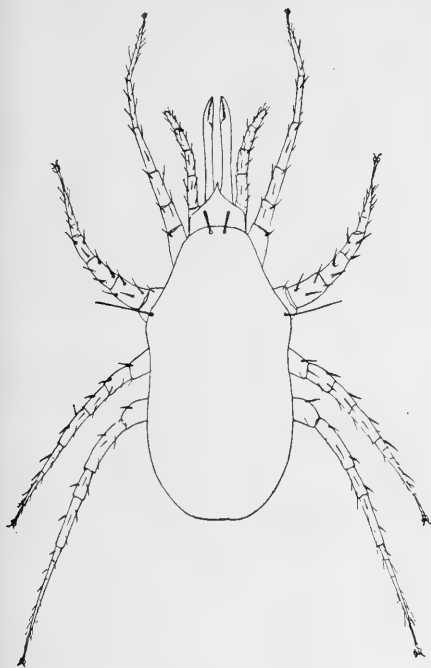


FIG. 99.—GAMASUS SP.

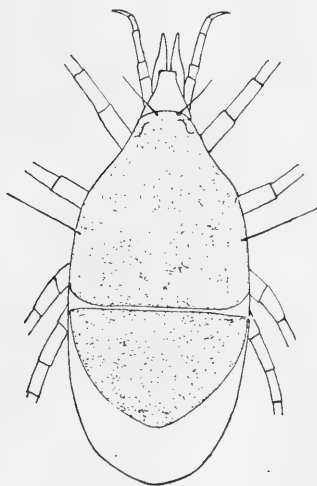
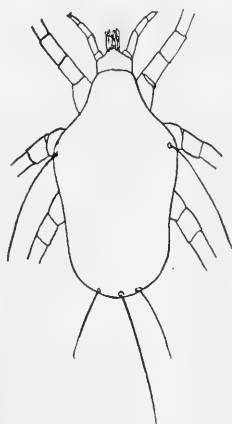


FIG. 100.—GAMASUS SP., NYMPH.

ber of species have been taken in ants' nests. Some of these live attached to the ants and obtain food from them. One species is so found on a *Scolopendra*. The relationship of the other forms to the ants is not clear in all cases. It has been shown by Michael that some species of *Laelaps* feed upon the dead ants. It is therefore probable that most, if not all, of these myrmecophilous forms are scavengers, and their presence useful to the health of the colony. The ants sometimes take care of the mites when the nest is disturbed, and carry them to a place of shelter. One species of *Laelaps*, *L. equitans*, was frequently observed to jump up on an ant and ride about for a while, the ant taking no notice of its rider. It appears that each species of mite prefers to live with a certain species of ant, but several kinds of mites have been found in the same nest. The mites disappear when the ants desert the nest.

The superfamily Gamasoidea is divisible into several natural groups, the relative importance of which has been variously estimated by different writers. I shall consider that there are

FIG. 101.—GAMASUS SP.,
LARVA.

three families—the Dermanyssidae, the Gamasidae, and the Uropodidae. They are not, however, as distinct as one could wish. They may best be separated as follows:

1. Parasitic on vertebrates; mandibles fitted for piercing; body sometimes constricted *Dermanyssidae*
Free, or attached to insects (rarely on vertebrates, never on birds) 2
2. First pair of legs inserted within the same body-opening (camerostome) as the oral tube; dorsum of body projects beyond the camerostome; genital apertures surrounded by the sternum *Uropodidae*
First pair of legs inserted at one side of the mouth opening; dorsal surface of body does not project in front of the camerostome, male genital aperture usually on the anterior margin of sternal plate (sometimes in the middle).
Gamasidae

The true Gamasidae are divided into a great number of genera. The family has not been carefully studied in the United States, so that the following table to the more prominent known genera includes several not yet recorded from the United States:

1. Living in the ears of cattle, horses, etc. *Raillietia*
Living upon moles, or in their nests *Hæmogamasus*
Not found on vertebrates 2
2. No peritreme, only the spiracle; leg I without claws; dorsal shield entire 3
Peritreme present 4
3. Spiracle elliptical; male genital aperture in anterior margin of sternal plate.
Iphiopsis
Spiracle, circular; male genital aperture in middle of sternum *Epicius*
4. Peritreme very short, about twice as long as wide; dorsal shield entire; leg I with claws; living in a cavity of the abdomen of certain bees (*Xylocopa*).
Greeniella a
Peritreme more than twice as long as broad; not parasitic on bees 5
5. Leg I without claws; dorsal shield undivided 6
Leg I with claws 10
6. A post-anal plate; genital aperture of female between second and third coxæ, and opening by two hinged plates; male with ventral plates united, and leg II unarmed *Celanopsis*
No post-anal plate; female genital opening normal, and farther back 7
7. Hind femora with several distinct teeth behind; leg II of male unarmed; male genital opening in middle of sternum *Megisthanus*
Hind femora unarmed, or, if so, then leg II is enlarged and armed in male, and male genital aperture on anterior margin of sternal plate 8
8. Peritreme not extending in front of coxæ III; body short; legs short; male with leg II unarmed; male genital aperture opens in middle of sternum; attached to arthropods *Antennophorus*
Peritreme extending much in front of coxæ III; male genital aperture on anterior margin of sternum 9
9. Male with leg II enlarged and armed with teeth; female often with metasternalia; peritreme often curved at base; body more elongate *Macrocheles*
Male with leg II unarmed; all legs very long; female without metasternalia.
Podocimum
10. Middle of dorsum with two small shields each side, a larger one at tip, and a very large one in front *Liroaspis*
Dorsum without such arrangement of shields, usually one, or one transversely divided 11

a New name to replace *Greenia* Oudemans (1900), preoccupied by Kirby in 1896.

11. Male genital opening in middle of sternal plate; body rather short and usually with hairs or spines12
 Male genital opening on anterior margin of sternal plate.....13
12. Peritreme rather short; dorsal shield divided; leg II of male unarmed....*Zercon*
 Peritreme long; dorsal shield entire; leg II of male armed with teeth....*Sciodes*
13. Leg II of male unarmed; body usually egg-shaped; dorsal shield entire14
 Leg II of male armed with teeth; body usually longer16
14. Male with ventral plates all united; anal plate separate in female; female genital plate not angulate in front*Laelaps*
 Anal plate separate in both sexes15
15. Anal plate broad; epistoma scarcely pointed*Seius*
 Anal plate small and narrowed behind; epistoma usually with a mucronate front*Hyletastes*^a
16. In female the sternal plate reaches behind hind coxæ; the ventral and genital plates united, the anal separate*Pachylaelaps*
 In female the sternal plate scarcely reaches hind coxæ; the ventral plate often united to anal, but not to genital17
17. Female genital plate triangular; angulate in front*Gamasus*
 Female genital plate rounded in front.....18
18. Dorsal shield entire.....*Hydrogamasus*
 Dorsal shield more or less divided19
19. Anal plate united to ventral.....*Gamasellus*
 Anal plate free*Cyrtolaelaps*

The genus *Railletia* is based on *R. auris*, which was found by Leidy in the ears of cattle in this country. Of *Iphiopsis* and *Epierius* no



FIG. 102.—HYLETASTES SP. AND ANAL PLATE.

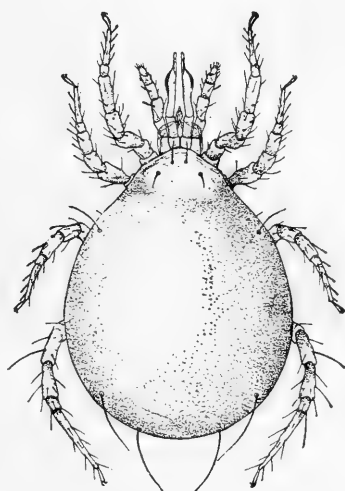


FIG. 103.—HYLETASTES OVALIS (PERGANDE).

species have been found in this country; the latter often has a regular pattern of tubercles on its dorsum. A species of *Clelenopsis* has been

^aGisl's genus (1848) to replace *Iphis* Koch, antedates *Eneus* Mégnin.

taken in Indiana and the District of Columbia on a Histerid beetle, *Hololepta*. *Meqisthanus* includes a number of large tropical Gamasids, recognized by their large size and toothed hind femora. One species, *M. floridanus* Banks, has been taken in Florida. *Antennophorus* has a very short, broad body, with short, stout legs. The first species was found in Europe abundantly attached to certain ants, and its habits have been studied by Wasmann and Janet. One species, *A. wheeleri* Wasmann, has been recorded, from the United States on ants. *Macrocheles* includes some of our most common species, but they have not been described, except one (*M. mastus* Banks) which

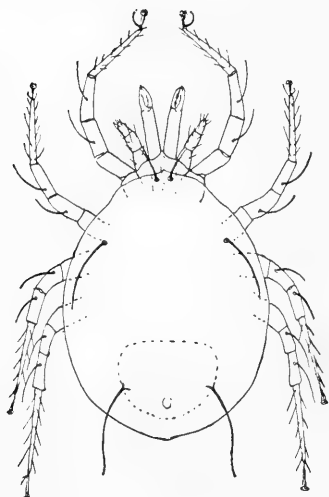


FIG. 104.—*SEJUS QUADRIPILIS*.

occurs in the nest of an ant, *Lasius americanus*. *Liroaspis* is a strange form found in the northern part of the country. Several species of *Laelaps* have been described, one from the nest of an ant, another, *L. placidus* Banks, from wet sphagnum moss. Of *Gamasus* we have a number of species that occur among fallen leaves, on the ground, in rubbish, etc. The genus *Hæmogamasus* is found on moles and in their nests, both in Europe and America. All stages are found at the same time, and evidently suck blood from the mole. I have taken one species in the United States. The other genera tabulated are known in Europe, and several others have been described from South America.

Berlese has recently divided *Laelaps* into several genera, one of them, *Myrmonyssus*, from forms on ants. Ribaga has also divided *Seiulus* or *Seius* into four subgenera.

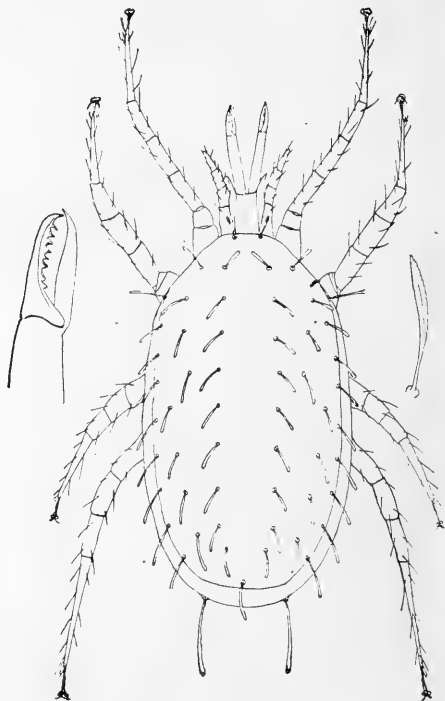


FIG. 105.—*LAELAPS MEXICANUS*, MANDIBLE, AND ENLARGED HAIR.

The Dermanyssidae, though differing much in general appearance from the Gamasidae, are closely allied by structure, and their parasitic habits are the best character for the separation. Probably it would be better to abandon the group. The principal genera can be arranged as follows:

1. Anal plate present.....(Dermanyssinae) 2
 Anal plate absent.....(Halarachninae) 5
2. Body short; legs very stout, hind pair reaching much beyond the tip of body.
 Pteroptus
 Body longer; hind legs not reaching beyond the tip..... 3
3. Peritreme on the dorsum, very short; body very distinctly constricted. *Ptilonyssus*
 Peritreme on venter, longer; body not distinctly constricted..... 4
4. Mandibles in both sexes chelate; parasitic on bats and mice *Liponyssus*
 Mandibles in male chelate, in female long, styliform; parasitic on birds.
 Dermanyssus
5. Dorsal shields present; coxæ close together; living in seals..... *Halarachne*
 No dorsal shields; hind coxæ separated from the fore; living in monkeys.
 Pneumonyssus

Pteroptus, which is parasitic on bats, is remarkable on account of

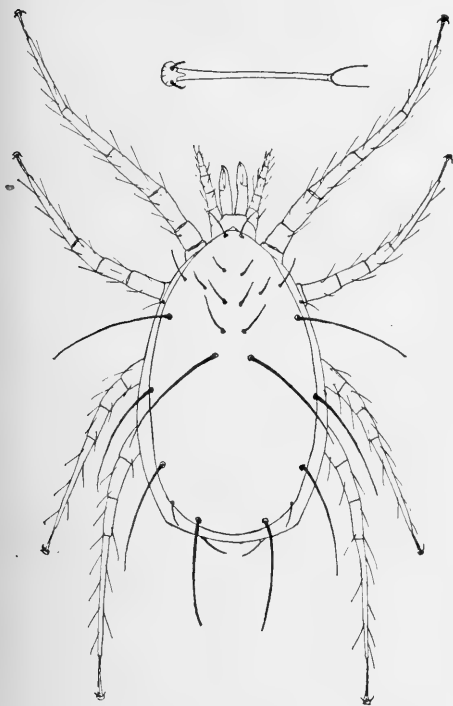


FIG. 106.—*LELAPS MACROPILIS* AND CARUNCLE OF TARSUS IV.

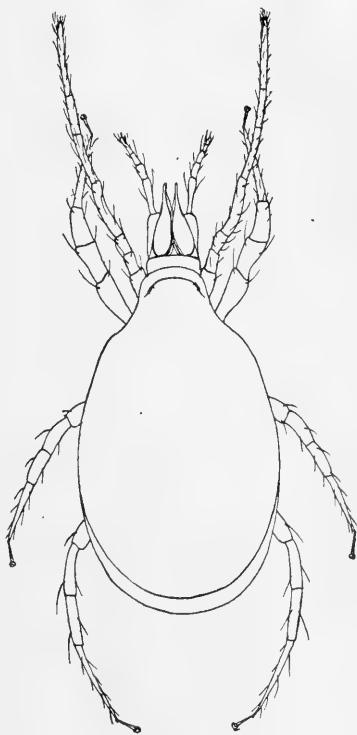


FIG. 107.—*MACROCHELES CAROLINENSIS*, FEMALE.

its curious shape, dorsal position of the stigmata, and also on account of the young hatching with the full complement of legs, the larval

stage having been passed in the mother. The abdomen is practically wanting in the male, and in the female it is extremely small. The short, thick, bristly legs are set at about equal distances around the body. Although the stigmata are on the dorsum, the peritreme extends down over the sides and upon the venter. Doctor Oudemans has described an accessory nymphal stage in one species of this genus. It occasionally issues from the second nymphal stage, and differs particularly in the nature of the vestiture. Its use is unknown. One species has been described from our country.

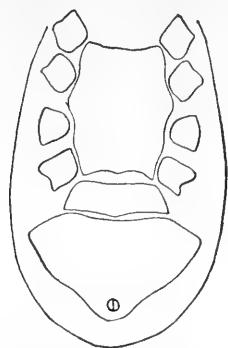


FIG. 108.—MACROCHELES CAROLINENSIS; VENTER OF FEMALE.

The allied genus *Perriglischrus* differs in having the dorsal shield divided, and the peritreme does not extend down on the venter. The female has a wrinkled fan-shaped expansion to tip of body, by which she retains hold of the skin of the bat. Kolenati described several allied genera, but most, if not all of them, are stages of *Pteroptus*.

The genus *Liponyssus* differs in having a large abdomen, separated by a constriction from the cephalothorax; it occurs on sparrows. The species of

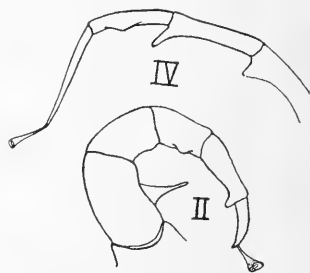


FIG. 109.—MACROCHELES SPINATUS; LEGS II AND IV OF MALE.

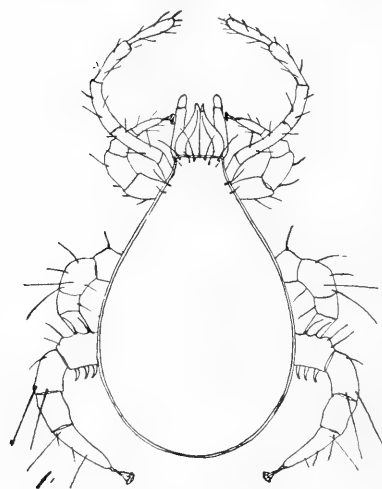


FIG. 110.—MEGISTHANUS FLORIDANUS.

Liponyssus are parasitic on mice and similar mammals. They are pale-colored, but otherwise much like *Dermanyssus*. The latter genus occurs on birds, especially those kept in domestication. *D. gallinæ* is a serious pest of poultry in many parts of the country. They hide in cracks and crevices by day, but at night crowd upon the fowls and suck their blood. They are more injurious in the Southern States than elsewhere. Sometimes they attack man and cause itching and soreness. Chickens endeavor to get rid of the mites by a dust-bath, but when the mites are numerous, it will be best to spray or

wash the hen-house with kerosene, benzine, or gasoline. Whitewashing with carbolated lime will destroy a great many of them. If the

ends of the roosts are daubed with coal-tar the mites will be unable to reach the fowls. A mixture of kerosene and sulphur plastered upon the roosts and in bottoms of the nests is also very useful. The same or an allied species occurs on cage birds.

The species of *Halarachne* are very elongate, and look somewhat like ticks; they inhabit the branchial passages of seals. *Pneumonyssus* occurs in cavities in the lungs of a Javanese monkey.

Doctor Trouessart has erected a subfamily, Rhinonyssinae, to include *Rhinonyssus*, *Ptilonyssus*, *Sternostomum*, and possibly *Halarachne*. The group is based on the dorsal position of the peritreme. The species of *Rhi-*

nonyssus and *Sternostomum* are found in the nasal cavities of various birds, one species, *S. rhinonlethrum*, thus infesting the domestic fowl. They have retractile claws, comparable to those of cats, which enable

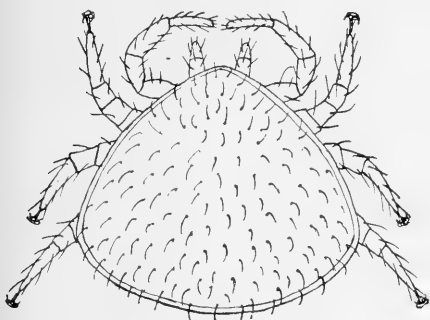


FIG. 111.—ANTENNOPHORUS UHLMANNI (AFTER HALLER).

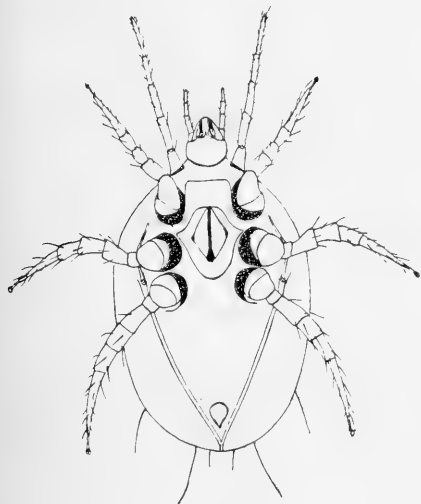


FIG. 112.—CELENOPSIS AMERICANA.

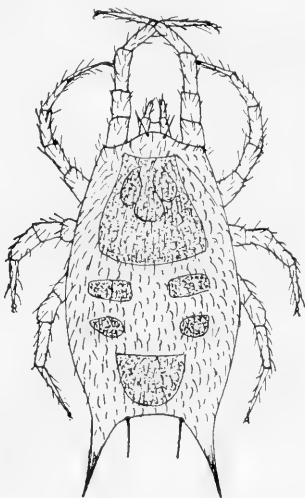


FIG. 113.—LIROASPIS AMERICANA.

the mite to retain its position. Their feeding may cause a catarrhal inflammation, but no remedy has been suggested. I am not aware that any of these forms have yet been taken in the United States. Berlese states that in *Sternostomum* and *Ancystropus* the anterior coxæ are contiguous above the rostrum. The latter genus was found on bats.

The Uropodidæ are divisible into comparatively few genera. In general appearance they are quite different from most of the Gamasidæ, being shorter and their legs more or less hidden under the body. They are familiar to most entomologists when attached to beetles and other insects. Besides the characters given in the table for the separation of these forms from the Gamasidæ, it may be added that the mandibles are very long and slender, ending in delicate chelæ. In fact the mandibles in some species are twice the length of the body, and when retracted the bend near the middle is near the posterior walls of the body. Most of the Uropodidæ that are found on insects are there

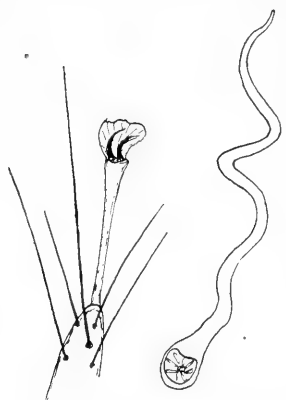


FIG. 114.—UROPODA; CARUNCLE AND PERITREME.

for the purpose of transportation and not as parasites, but in certain forms found on ants the mite is a true parasite. The species that use the insect as an aid

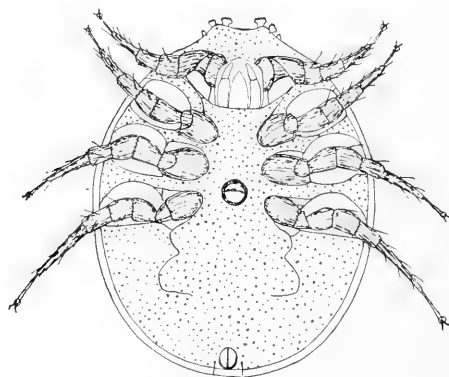


FIG. 116.—UROPODA SP., FROM BELOW.



FIG. 115.—UROPODA SP. *p.*, PEDICEL.

to migration are attached thereto by a pedicel of excrement; those that are true parasites are not so attached. Most of those that are attached by this anal pedicel are not adults, but in a nymphal stage, and are called "*nympha pedunculata*." The mite can detach itself by a fresh excretion. They occur on insects that breed in places suitable for the mites. There-

fore the mites are sure to be carried to a spot where they can drop off and find the desired breeding grounds—decayed wood, humus, manure, or fallen leaves. Sometimes the insect is so completely covered by the mites that it can not be seen.

The genera may be tabulated as follows:

- | | |
|----------------------------------------------------------------------------------|-------------------|
| 1. Venter provided with impressed foveæ for the reception of the legs..... | 2 |
| No such foveæ..... | 4 |
| 2. Body irregular, dorsum sculptured | <i>Glyphopsis</i> |
| Body regular in form; dorsum evenly convex; no sculpture, except punctuation. 3. | |
| 3. Leg I provided with claws..... | <i>Uropoda</i> |
| Leg I without claws..... | <i>Cilliba</i> |

- | | |
|-----------------------------------------------------------------------------------------------------------------------|------------------|
| 4. Leg I without claws..... | 5 |
| Leg I with claws..... | 6 |
| 5. Legs with scale-like hairs; dorsal and ventral plates separate and distinct..... | <i>Polyaspis</i> |
| Legs without such hairs, no ventral plate..... | <i>Uroseius</i> |
| 6. Dorsum covered by one plate fused to the ventral plate; peritreme sinuate; anterior coxæ contiguous..... | <i>Dinychus</i> |
| Dorsum with several plates, not fused to the ventral plates; peritreme but little curved; anterior coxæ separate..... | <i>Trachytes</i> |

Our species of the family have been but little studied, and only three of the above genera are known in this country.

Species of *Uropoda* are frequently found attached to various beetles. One of these is common on the Colorado potato beetle, and it was formerly supposed by many economic entomologists that the mites fed upon the beetle.

It has lately been claimed that some species feed on bac-

teria and small fungi. The species are very numerous; some are smooth, others hairy; nearly all of a red-brown fawn color. The species of *Glyphopsis* have usually been found in ants' nests, and seem to live on good terms with the ants, although their exact status is not known. *Uroseius* and *Polyaspis* are based on a few forms, and not well known.

Trachytes contains two or three pyriform species found in moss; the genus was formerly called *Celaeno*. *Cilliba* (formerly known as *Discopoma*) is similar in appearance to *Uropoda*. Some species have been found in moss, but others occur parasitically upon ants, attached to the thorax or abdomen. One of our species, *C. circularis* Banks has been found thus fastened to the thorax of *Cremastogaster lineolata*. Another species, *C. hirsuta* Banks, was taken upon a species of *Lasius* in Arizona.

The relations existing between the *Discopoma* and the ant has formed the subject of several

recent investigations, both by Wasmann and by Janet. The mites which cling to the abdomen of the ant do not seem to be disturbed by the ant, but if a mite was placed on the ground of the nest it was seized and destroyed by the ants. The mites bite through the soft skin situated between the segments, and thus draw blood from their hosts.

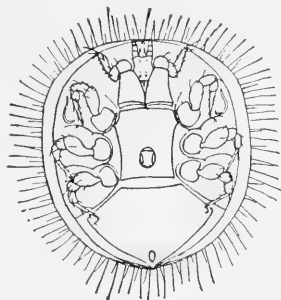


FIG. 117.—*CILLIBA HIRSUTA*, FROM BELOW.

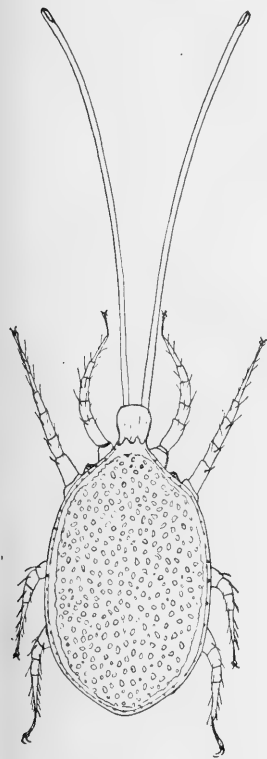


FIG. 118.—*DINYCHUS AMERICANUS*.

The genus *Dinychus* is peculiar in having enormously long extensile, flexible mandibles. The mandibles are more than twice as long as the entire animal, and can be retracted so that the bend in them is close against the posterior walls of the abdomen. The tips of these mandibles are distinctly chelate. We have one species in this country.



FIG. 119.—LEG, MANDIBLE, AND PSEUDOSTIGMATIC ORGAN OF AN ORIBATID.

From New Guinea, Canestrini has described several species of a remarkable genus—*Derañophorus*. They have a pair of plate-like projections over the head, and from these arise long bristles, and there are also bristles at tip of abdomen. Two other genera, *Uropodella* and *Fedrizzia*, have been described from tropical countries.

Superfamily ORIBATOIDEA.

The Oribatid mites may usually be recognized by the presence of a single character, a hair or seta arising from a small pore near each posterior corner of the cephalothorax. This pore was formerly considered a spiracle, but it is now known not to be such. Its function, however, is uncertain, and it is called a pseudo-stigmata,

while the hair arising therefrom is known as the pseudo-stigmatic organ.

With the great majority of the Oribatidæ the tegument is coriaceous; it is because of this that these mites have been called "beetle mites." This name is somewhat misleading, as members of another family, the Gamasidæ, are often attached to beetles, and therefore sometimes termed "beetle mites."

The body of an Oribatid is short, broad, and usually high. There is always more or less indication, usually very plain, of the division into cephalothorax and abdomen. There is at this point a constriction on the sides, a line or suture on the venter,



FIG. 120.—HOPLODÈRMA SPHERULA.

and a break in the continuity of the dorsal outline. The posterior pairs of legs are apparently attached to the abdomen. The coxæ of the legs

are arranged in a somewhat radiate manner, and the hind pairs are never remote from the anterior pairs. Each leg is composed of six joints, namely, coxa, trochanter, femur, patella, tibia, and tarsus. Sometimes there is a plate-like expansion near base of coxæ, known as a tectopedium. The coxæ are usually entirely united to the ventral surface of the body to form a sternal, or, more properly, a coxal plate, each coxa usually being margined by a short furrow. In *Nothrus*, however, the coxæ may be seen to be quite distinct from the body. On the first two pairs of legs the trochanter is extremely small and usually indistinct, while this joint is often very large on the hind pairs. So it follows that the hind legs have, apparently, one more joint than the front pairs. The tarsus is terminated by one or three claws, but without a sucker or pulvillus. The legs bear a few hairs, but never many; one at the tip of the tibia is often much longer than the others. The tarsus is commonly more hairy than the other joints.

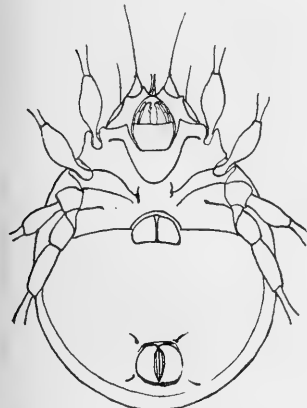


FIG. 122.—*GALUMNA* SP., FROM BELOW.

On the dorsum of the cephalothorax there are often narrow ridges or lamellæ; the position, shape and development of these being characteristic of each species. Generally there is an erect lamella each side, extending in a point (sometimes bifid) in front of the cephalothorax. Frequently there is a trans-lamella connecting the lateral lamellæ. There are also on the cephalothorax usually two pairs of bristles, the pair near and between the pseudostigmata are the superior bristles; the pair toward the tip and often at ends of the lamellæ are the inferior bristles. There is also a pair of smaller bristles at the apex of the cephalothorax. Around the sides of the abdomen there is a line separating the dorsum from the venter. In the *Hoplodermidæ* this line is often far down on the under side of the body. The dorsum of the abdomen is often devoid of hairs, but sometimes there are a few, usually arranged in rows. On the venter are two openings, the basal the genital one as usual. These openings are circular, elliptical, or rhomboidal, and are closed by folding doors opening outward,

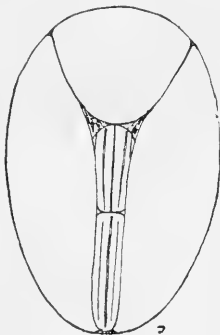


FIG. 121.—*PHTHIRACARUS* SP., CLOSED UP; VENTRAL VIEW.

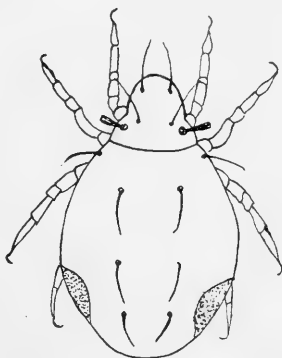


FIG. 123.—NYMPH OF A *GALUMNA*.

and hinged to the outer margins of the apertures. In many forms these apertures are very large and occupy the greater part of the venter, in other and more highly organized species the openings are much smaller and quite remote from each other.

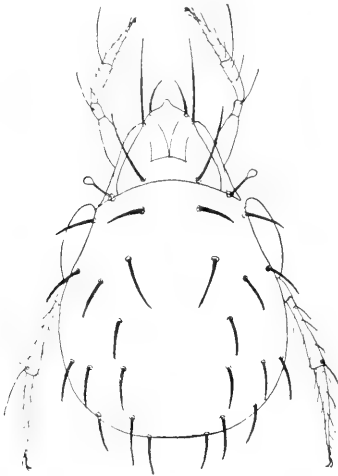


FIG. 124.—*GALUMNA HUBBARDI*.

The mouth-parts of the Oribatidæ are obscure. The palpi are very small, five-jointed, and arise from the labium. They are usually in motion while the mite is walking. The mandibles are chelate in all save the genus *Serrarius*. The limbs of the chelæ are commonly toothed on the inner sides. In *Serrarius* the mandibles are elongated and rod-like, and there is no movable limb at tip; the sides are serrate, so that the mandibles act as a saw. The maxillæ have their basal joints united into one transverse piece, the labium, which partly and sometimes wholly closes the mouth-orifice. The maxillæ incline slightly toward each other; their tips are broad and toothed. The Oribatidæ

deposit the eggs in crevices of wood, moss, fungi, or on the ground. The six-legged larva remains for a few weeks in this stage, when, by a molt, it becomes an eight-legged nymph. The nymph passes through three molts, increasing in size at each, the third molt bringing it to

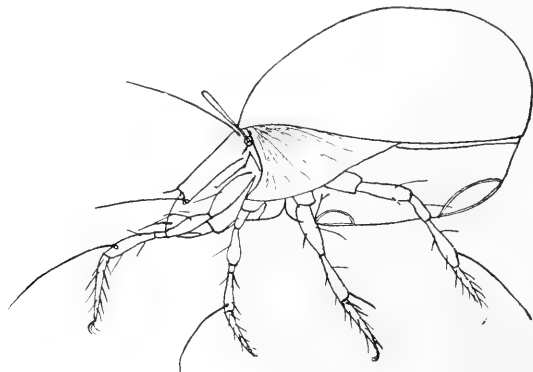


FIG. 125.—*ORIBATELLA ARMATA*.

the adult condition. In some cases the eggs are not deposited, but ripen in the body of the parent mite, the mother then dies and dries up, her old shell remaining as a protection for the eggs till they hatch. In some species the egg has a hard shell; the growth of the embryo splits the shell and shows the pale vitelline membrane as a white band around the egg.

The larvæ and nymphs are always monodactyle—that is, with one claw to tarsus. Their skin is soft and flexible. There are few creatures more bizarre or remarkable than the nymphs of certain Oribatidæ. Some bear upon the back concentric rings of beautifully

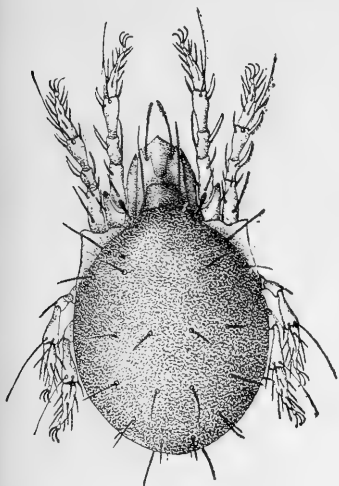


FIG. 126.—ORIBATELLA SP. (PERGANDE).

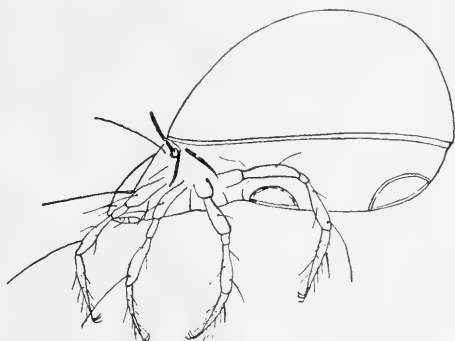


FIG. 127.—LIACARUS NITIDUS.

iridescent, membraneous, fan-shaped scales. Others carry a collection of their molted skins, eggshells, bits of dirt, moss, etc.—a veritable peddler's pack of trash. Many species have rows of serrate hairs on their backs. The skin of the back of many nymphs is wrinkled so as to allow for growth. Many of these nymphs were described by early writers on Acari as distinct species.

When a nymph is about to become an imago, it seeks some sheltered spot and fixing its legs firmly in the substance upon which it rests, it gradually becomes inert and apparently dead. It remains in this condition about ten days. When about to transform to the adult the skin splits behind and shows the imago beneath; this split increases without any perceptible movement of the mite, until it is quite large, when the mite begins to back out of its old shell. It may then be seen that the legs of the adult are not withdrawn from the legs of the nymph, but were folded beneath the adult.

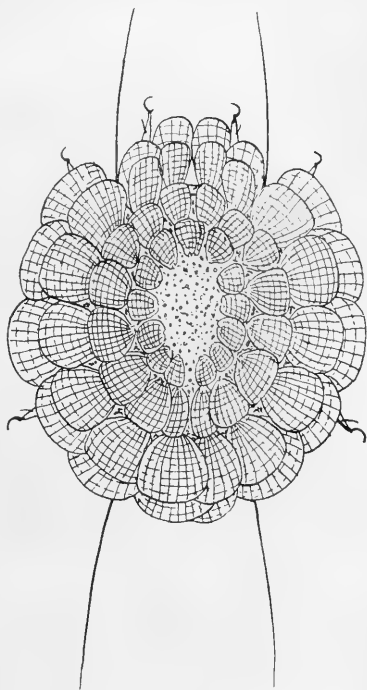


FIG. 128.—LIACARUS SP., NYMPH.

The internal anatomy of the Oribatidæ is quite well known, having been investigated by Nicolet and later and more thoroughly by Michael. The alimentary canal is composed of a pharynx, œsophagus, stomach or ventriculus, intestine, colon, and rectum. The œsophagus has, near its posterior part, an enlargement or ingluvies of varying size, according to the species. The stomach is a large sac in the upper part of the abdomen, provided with two large cæca, one each side, reaching back to near the tip of the abdomen. The small intestine is very short and enlarges to the colon, which is separated from the rectum by a constriction. In most, if not all, forms there are two large glands, the preventricular glands, which open into the ventriculus near the cæca.

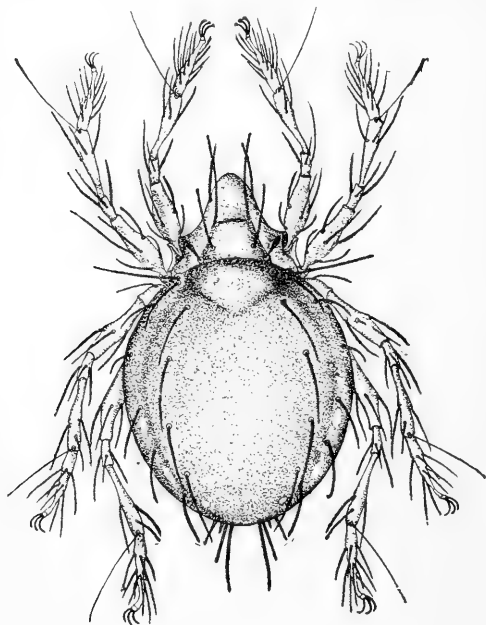


FIG. 129.—EREMEUS PILOSUS (PERGANDE).

They are supposed to secrete some fluid useful in digestion. The male organs of generation consist of one central testis, usually large, two vasa deferentia, uniting into a ductus ejaculatorius, which opens through an extensile penis. In the female there is a median ovary (sometimes showing traces of division) opening into two oviducts which unite in a vagina; the latter opens through a protrusible ovipositor. It is possible that the ovary is connected by two fine tubes to an aperture near the anus, and that this is the • bursa copulatrix.

Coition, however, has not been observed, so it is not certain that the male does not use the vagina.

The tracheæ when present vary much in shape and size. They open at the acetabula of the legs; one or two tracheæ proceed from each acetabulum; sometimes very long, and wind about in the body; sometimes short, and again may be enlarged to form air sacs. In *Hoplodermia* there are no tracheæ, and in *Nothrus* they are rudimentary, and they are lacking in the larvæ and nymphs of all forms. There are various excretory organs; one pair, the supracoxal glands, open near the acetabula of the second legs; others, the expulsores open on the sides of the abdomen. The Oribatidæ have a delicate sense of touch, which resides apparently in the long hairs or setæ upon the legs, particularly a very long hair on the tibia. They

have no eyes, yet have a quick appreciation of light and darkness, and prefer the latter. It is quite possible that the pseudo-stigmata are organs of hearing.

The food of the Oribatidæ is usually of vegetable nature, but a few species affect decaying animal matter; one of our common species is usually found on bones. Many feed on lichens and fungi, and some bore into decaying wood. Several kinds are found on the bark of living trees, and others under dead bark. Many species

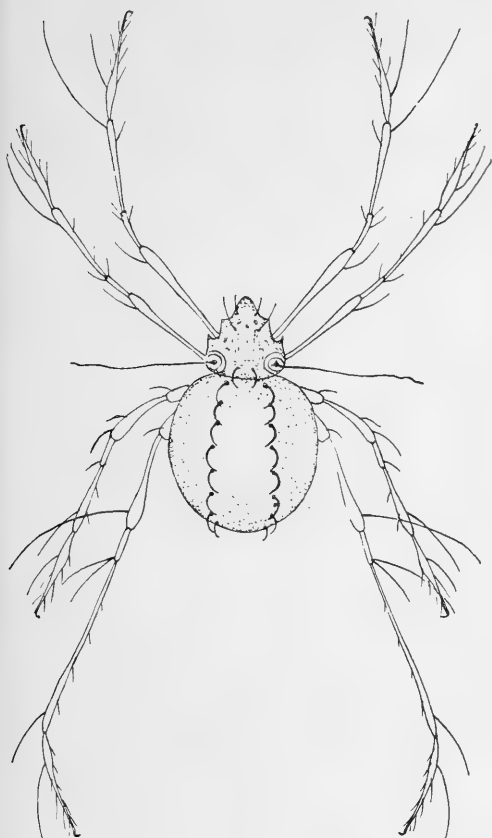


FIG. 130.—ORIBATA GRACILIPES.

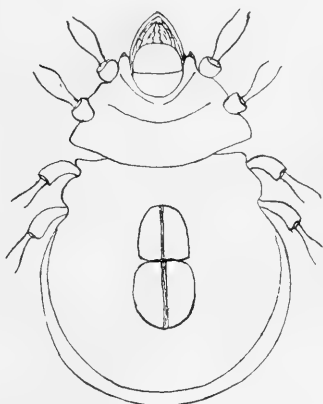


FIG. 131.—VENTER OF ORIBATA.

occur in moss, but do not necessarily feed upon it. Most species are slow in traveling, and often, when disturbed, feign death. Many of the adult mites carry their molted skins and other rubbish on their back.

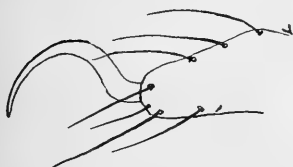


FIG. 132.—CLAW OF AN ORIBATA.



FIG. 133.—LARVA OF AN ORIBATA.

Practically none of the Oribatidæ are of economic importance. A few have been recorded as damaging grass; but as a whole they prob-

ably are slightly beneficial. There are doubtless 200 species of this family in the United States, but only about fifty or sixty, mainly from



FIG. 134.—ORIBATA MINUTA.

the Eastern States, have been described. On account of their minute size, obscure habits, and small economic value they are not favorites with collectors.

The superfamily Oribatoidea includes two well-marked families. One, the Hoplodermidae, are separated from the genuine Oribatidae in having the cephalothorax movably attached to the abdomen. By this means the animal is able to roll up, concealing the legs. The legs of the Hoplodermidae are attached to the body, close together,

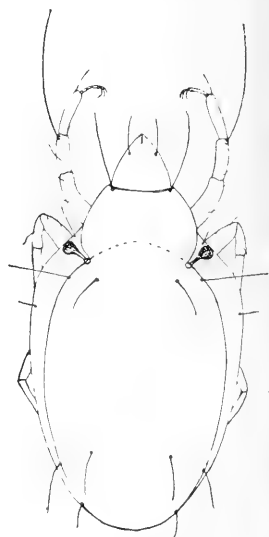


FIG. 135.—GYMNOBATES GLABER.

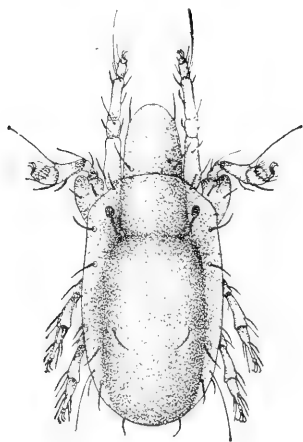


FIG. 136.—ORIPODA ELONGATA (PERGANDE).

and the whole sternal structure is soft and membranous, instead of coriaceous as in the Oribatidae. The palpi are four-jointed. The dorsal plate of the abdomen extends down upon the sides, so that the venter is very narrow and almost wholly occupied by the large genital and anal apertures. We have two genera of this family—*Hoploderma*, with one claw to tarsus, and *Phthiracarus*, with three claws to tarsus, and a narrower venter. We have a few species in each genus; *Phthiracarus glabrata* Say is one of our largest and most common forms, and is found on moist ground. The species of *Hoploderma* are most common in decaying wood or moss.

When disturbed they roll up, play "possum," and are then not easily discerned. One of the species described by Doctor Riley was supposed to feed on the *Phylloxera*, but such is not the case.

In the true Oribatidæ there are a great many genera, and there appears to be much doubt as to the proper names of several of them, owing to the work of old authors who had no idea of the rules of modern nomenclature. The forms, as far as known, can be grouped as follows:

1. Abdomen with wing-like expansions at the anterior sides	2
Abdomen without wing-like expansions.....	6
2. Superior bristles spatulate; mandibles elongate.....	<i>Pelops</i>
Superior bristles not spatulate	3
3. Tarsi broad at tip, three claws	<i>Gymnolates</i>
Tarsi tapering to tip	4
4. With three claws to tarsus	5
With but one claw to tarsus.....	<i>Oribatodes</i>
5. Cephalothorax with lamellæ large, and attached to cephalothorax for only part of their length.....	<i>Oribatella</i>
Cephalothorax with smaller lamellæ, attached for nearly their whole length,	<i>Galumna</i>
6. Cephalothorax with lamellæ.....	7
Cephalothorax without lamellæ	11
7. Body smooth.....	8
Body more or less rough	9
8. Legs II, III, and IV inserted under body.....	<i>Liaccarus</i>
Legs inserted more on side of body.....	<i>Eremacus</i>
9. Cephalothorax and abdomen plainly separated on dorsum.....	10
Cephalothorax and abdomen more or less united	<i>Scutorvertex</i>
10. Claws three; femora I and II not pedunculate.....	<i>Notaspis</i>
Claw one; femora I and II pedunculate	<i>Carabodes</i>
11. Legs slender, longer than body	12
Legs short and thick	13
12. Claws three	<i>Gymnodamæus</i>
Claw one	<i>Oribata</i>
13. Abdomen transversely segmented.....	<i>Hypochthonius</i>
Abdomen not transversely segmented	14
14. Claw one; dorsum convex	<i>Hermannia</i>
Claws three	15
15. Dorsum very convex, with concentric rings	<i>Neoliodes</i>
Dorsum quite flat, without concentric rings.....	16
16. Leg II with tectopedia; dorsum coriaceous; body elliptical.....	<i>Cymeremacus</i>
Leg II without tectopedia; dorsum softer; body more rectangular.....	<i>Nothrus</i>

Most of our common forms belong to either *Galumna* or *Oribatella*. They are usually shining black in color, sometimes with a pale spot at base of abdomen, and rarely with hairs or bristles above. They have the anterior sides of the dorsal integument extended downward in a wing-like expansion. The shape of this "wing" is characteristic in each species. Many species can be sifted from moss. They at first remain quiescent, but after a few moments start to crawl away.

G. pratensis Banks may be swept from meadows in great numbers, and doubtless injures grass to some extent. *O. aquatica* Banks lives on aquatic plants, and can readily walk on the surface of stagnant water, yet there seems to be nothing peculiar in the structure of the

tarsi. *G. arborea* Banks and *G. affinis* Banks occur on the bark of trees. *G. hirsuta* Banks is a pale yellowish form, with a bristly body, occurring in dry sandy places.

One of our common forms and one of the largest of the family, being fully one millimeter long, is *Liaccarus nitidus* Banks. It occurs on the ground under pieces of wood, bark, stones, and fallen leaves. A species of *Eremæus*, *E. pilosus* Banks, is common in the crevices of bark of living trees. There are four rows of bristles on the abdomen. A species of *Scutovortex*, *S. marinus* Banks, is not uncommon on rocks between tide

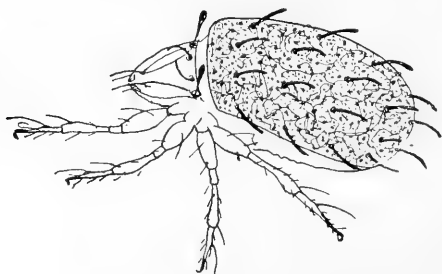


FIG. 137.—CARABODES BREVIS.

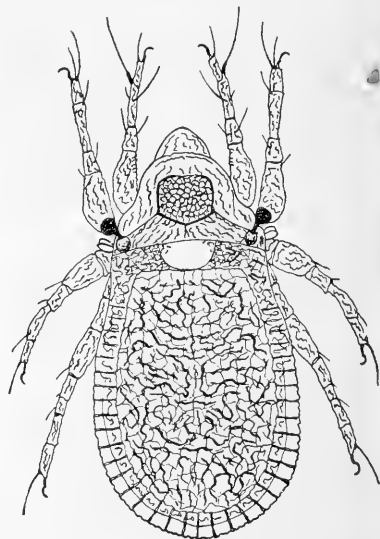


FIG. 138.—CYMBEREMÆUS MARGINALIS.

marks on the Atlantic seashore. It appears to lack the pseudo-stigmatic organs and is otherwise peculiar. *Notaspis punctulatus* Banks is a pretty species, with a deeply pitted dorsum, and is found in decaying fungi.

Of *Carabodes* we have several species, some of which are found in fungi. Our most abundant species, *C. niger* Banks, which occurs in fungi, has four rows of spatulate hairs on dorsum. *C. oblonga* Banks was found boring under the bark of a stump, and it looks much like a tiny scolytid beetle. A species of *Oribata*, *O. minuta* Banks, occurs in moss and on decaying animal substances. It is pale yellowish-brown in color and appears to be widely distributed. The largest Oribatid we have is *Neoliodes concentricus* Say, a black species with concentric rings on its elevated abdomen.

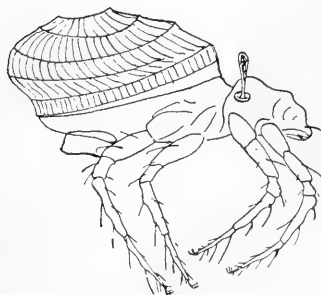


FIG. 139.—NEOLIODES CONCENTRICUS.

It occurs in crevices of bark of living trees throughout the Eastern States, and also in Europe. Our one species of *Cymberemæus*, *C. marginalis* Banks, occurs under lichens on the bark of trees in the Eastern States.

We have various species of *Nothrus*. They are very rough-looking

creatures, with a squarish body and short, rough legs. *N. truncatus* Banks occurs in sphagnum moss and on the ground in wet fields. *N. erebus* Banks occurs on the bark of spruce trees, where it is much protected by its color. Another species, *N. simplex* Banks, was found among lichens on dry rocks. *N. rugulosus* Banks is a common form under loose bark; it can scarcely be distinguished from the bits of dirt among which it lives.

The genus *Hypochthonius* has not been found in this country. It has a soft skin, which usually shows traces of segmentation. They occur in moss and damp places. The genus *Pelops*, closely related to *Galumna*, is likewise not yet known in this country.

As an appendix to the Oribatoidea may be added the genus *Nicoletiella* Canestrini, a genus represented by two European and one Central American species. It differs from the other Oribatidæ in the large and prominent chelate mandibles, by the indefinite pseudostigmatic organs, the complete union of cephalothorax and abdomen, and by having but one large aperture on the venter near its tip, which includes both anal and genital openings. The coxæ are all close together, and touch on the median line. The palpi are very short and simple. Legs I and II end in two claws; legs III and IV end in three claws. The species occur on

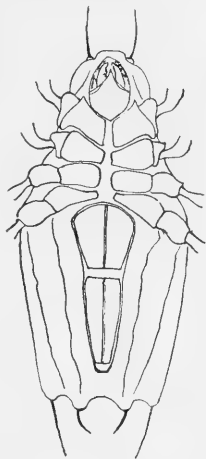


FIG. 140.—VENTER OF A
NOTHRUS.

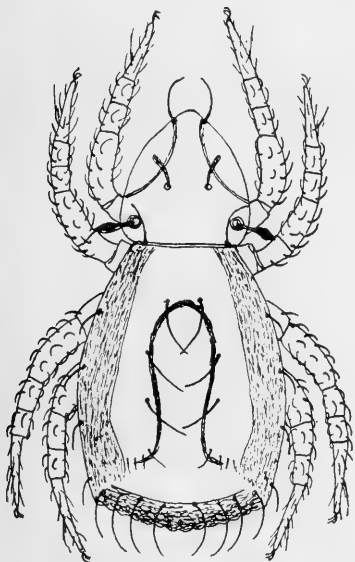


FIG. 141.—NOTHRUS BANKSI.

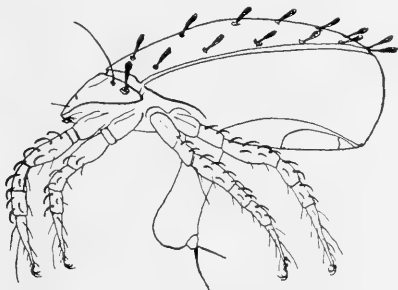


FIG. 142.—NOTHRUS TRUNCATUS.

the ground, under stones, dead leaves, and in moss. They have much resemblance to some Gamasidæ.

Family TARSONEMIDÆ.

This is a small family, but of much biological and economical interest. They are soft-bodied mites, and in some ways resemble the

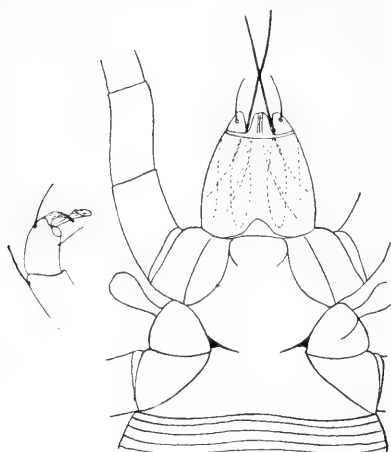


FIG. 143.—BEAK AND CLAW OF PEDICULOIDES.

Tyroglyphidæ, but the females differ from them, as well as from all other acarians, in having between legs I and II a prominent clavate organ of uncertain use. The mouth-parts are formed for sucking, and the mandibles are very slender and needle-like. The palpi are minute and barely visible. There are tracheæ which open on the ventral surface near the base of the rostrum. The legs are short and composed of five or six joints; the anterior tarsi terminate in one claw, the others usually have two claws and often a sucker. The posterior pairs of legs

are quite remote from the anterior pairs; in the males of *Tarsonemus* they are almost at the tip of the body. In some species the abdomen shows traces of segmentation by the presence of a few transverse lines on the dorsum. The anal opening is at the end of the body; the genital opening in *Tarsonemus* is a small, elongate aperture near the hind coxæ. The body and legs are provided with a few simple hairs. In several genera of the family, notably in *Tarsonemus*, there is a marked difference in the structure of the sexes. In the male *Tarsonemus* the body is much shorter than in the female, the hind legs are thick and heavy, and end in a very large claw. In the female the hind legs are very slender and delicate, and terminate in two long hairs, one of them often as long as the entire leg. In the mature female of *Pediculoides* the abdomen becomes enormously swollen so that it is 20 to 100 times greater than the rest of the body; the whole animal appearing as a white spherical grain, with a tiny scar on one side. The male of *Pediculoides* has almost no abdomen at all; the body being very short, and angulate behind. The head in this genus is almost a distinct

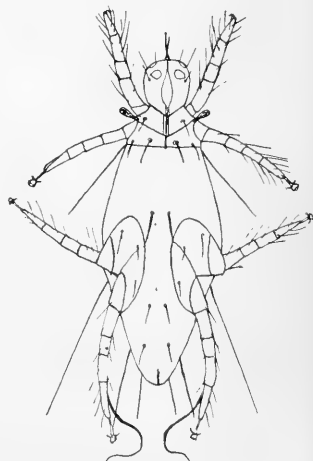


FIG. 144.—PEDICULOIDES VENTRICOSUS, FEMALE.

portion of the body. Brucker has studied the anatomy of *Pediculoides*; there is a large stomach, connecting to the mouth by a slender œsophagus; to the latter is attached a blind pharynx. He found no anus (but I believe one exists in *Tarsonemus*) the intestine ending blindly near tip of body. The genital opening is at tip of the body; above it is a short spermatheca. In the females there are a pair of air reservoirs in the front part of body; behind them are tufts of tracheæ, which, when the female becomes swollen by eggs, extend into the swollen part.

The Tarsonemidæ have not long held any one position in the system of Acarina. They have been associated with Oribatidæ and Cheyletidæ, and Berlese has recently elevated the family into one of the principal groups of the order. The dimorphism in certain forms seems to suggest affinity to the Tyroglyphidæ.

The family has been divided into two groups.

Hind legs of female ending in claw and sucker as in other pairs *Pediculoidina*
 Hind legs of female end in long hairs *Tarsonemina*

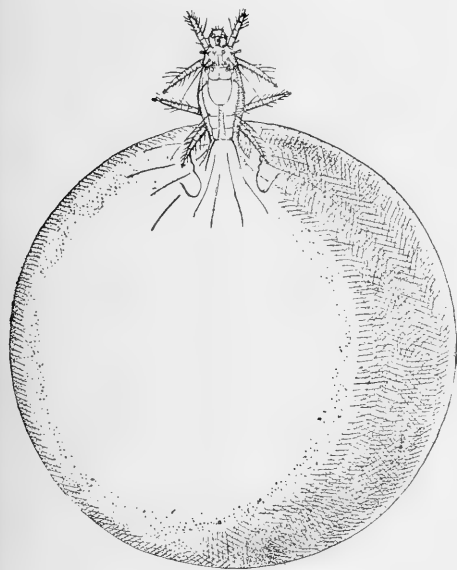


FIG. 146.—*PEDICULOIDES VENTRICOSUS*, GRAVID FEMALE
 (BUREAU OF ENTOMOLOGY).

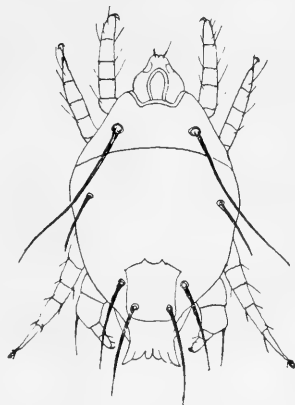


FIG. 145.—*PEDICULOIDES VENTRICOSUS*, MALE.

In the first subfamily are two or three genera, the most prominent is *Pediculoides*.

In 1850 Newport gave the name *Heteropus ventricosus* to a mite found on the larva of a wasp. Since then the same mite has been found on various insects, both alive and dead. The generic name was pre-occupied, and was changed to *Pediculoides* by Targioni-Tozzetti in 1875. The species has become of much economic importance since it is frequently parasitic upon injurious insects. The abdomen of the pregnant female swells to an enormous size, this being due to the development of the eggs. These not

only hatch within the parent, but obtain their entire development there, and issue as sexually mature males and females. These may wander about for a time on the body of the mother and soon pair.

The body of the male ends in a broad sucker, wherein is situated the penis. The tip of the female is grasped by this sucker. *P. ventricosus* occurs commonly in this country, and another species has been

found on the larvæ of scolytid beetles. Professor Herrera, the Mexican entomologist, has endeavored to breed a Mexican species to kill the grubs of the cotton-boll weevil.

Several other species have been assigned to this genus which feed on grain and grasses. One would suspect that they would fall in a separate genus, for which the name *Siteroptes* Amerling is available. One is *P. tritici*, found in wheat heads; another is *P. graminis* which Reuter has described as partly responsible for "silver-top" in certain grasses.

Pigmeophorus is closely allied to *Pediculoides*. It has a migratorial form, which in one case was found

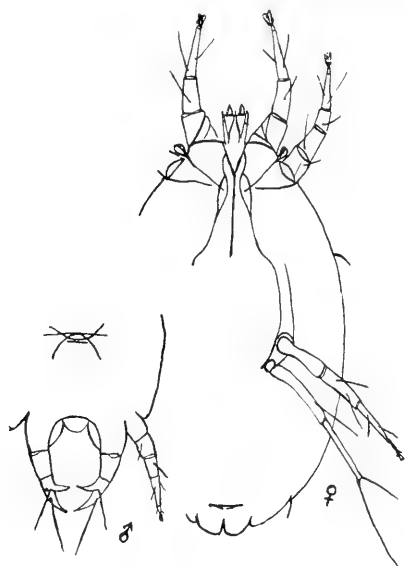


FIG. 147.—TARSONEMUS PALLIDUS.

on a mole, and in another on a fly. We have observed a species in this country attached in some numbers to a fly—*Platynemus imperfecta*. The genus

Podapolipus has been found upon grasshoppers. The male is reported to have but three pairs of legs, and the female but two pairs.

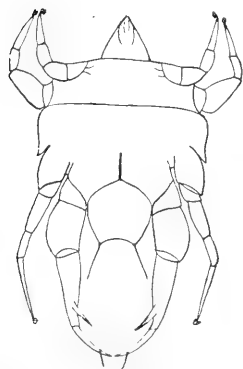


FIG. 149.—TARSONEMUS LATUS, MALE.

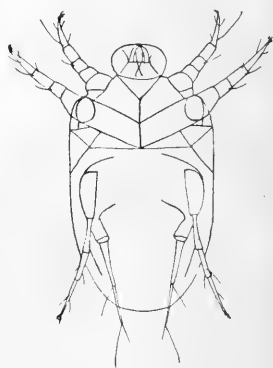


FIG. 148.—TARSONEMUS LATUS, FEMALE.

In the *Tarsoneminæ* are two genera—*Tarsonemus* and *Disparipus*. The species of

Tarsonemus affect various plants, sometimes producing galls upon them. They live in colonies upon the leaf or stem, or in the culms

of grasses. One species, *T. oryzae*, infests rice in Italy; another, *T. culmicola*, produces "silver-top" in certain grasses of Finland; a similar form produces the same appearance in some grasses of New Mexico. One grass-stem may contain several million mites. Another species does considerable damage to tea in Ceylon. Tryon has

described a species, *T. anasæ*, as injuring pineapples in Australia. I have described one, *T. latus*, which causes galls on the main shoots of mango plants. Another species, *T. pallidus*, has been found on various greenhouse plants in this country. Karpelles described a species, *T. intactus* (apparently identical with the *Chrithoptes monunguiculatus* of Geber), as attacking men in the Danube region of Hungary and Russia. The men had been handling barley and the mites spread from this to the hands, where they caused an irritating inflammation of the skin so intense as to force the men to leave their work. Michael has recorded a species, *T. bancrofti*, as the cause of serious damage to sugar cane in Queensland and also in Barbados. *T. canestrinii* produces small, rounded galls on several European grasses; *T. spirifex* forms elongate swellings on oats. But few remedies have been proposed for these mites; a mixture of powdered sulphur in soap and water has been suggested for the one on sugar cane. Probably the remedies for "red-spider" will be found applicable to them.

The curious genus, *Disparipes*, has a migratorial nymphal stage much like the *Hypopus* of the Tyroglyphidæ. This stage has been found on

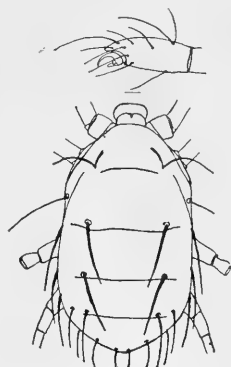


FIG. 150.—PIGMEOPHORUS AMERICANUS, FROM ABOVE, AND TARSUS ENLARGED.

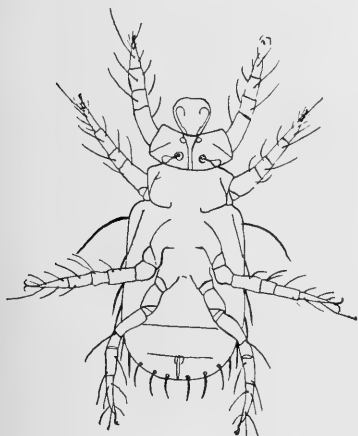


FIG. 151.—PIGMEOPHORUS AMERICANUS, FROM BELOW.

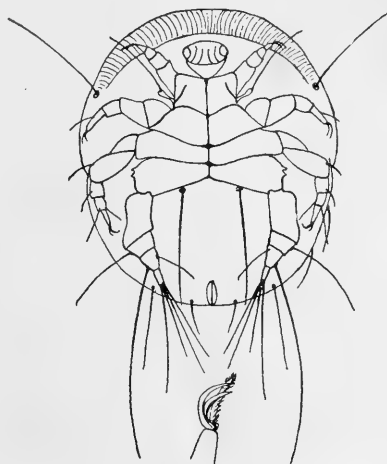


FIG. 152.—DISPARIPES AMERICANUS, FROM BELOW, AND CLAW.

bumblebees and ants. The adults occur on plants. I have seen specimens of an American species taken from a bee of the genus *Halictus*. Berlese has recently described a number of species taken from ants, and proposes to divide the genus into three groups, the two new ones being *Diversipes* and *Imparipes*; the characters, however, are very slight.

Family TYROGLYPHIDÆ.

The Tyroglyphidæ (*Sarcoptides détricoles* of Mégnin) are not a large family of mites, but many of them are of considerable economic importance, since several of them affect stored foods and the roots and bulbs of living plants. They have been known to naturalists from the time of Linnæus. In the adult condition they are usually free, but during one stage of their life, known as the hypopial, they are attached to various insects and sometimes small mammals. This hypopial stage, or hypopus, is a migratorial condition; the mite during this period takes no food, so it is not a true parasite. However, in some cases where they occur in enormous numbers they may injure the insect, owing to their weight or position.

The Tyroglyphidæ are pale-colored, soft-bodied mites, devoid of tracheæ, usually with prominent chelate mandibles, small palpi, moderately long legs, ending in one claw

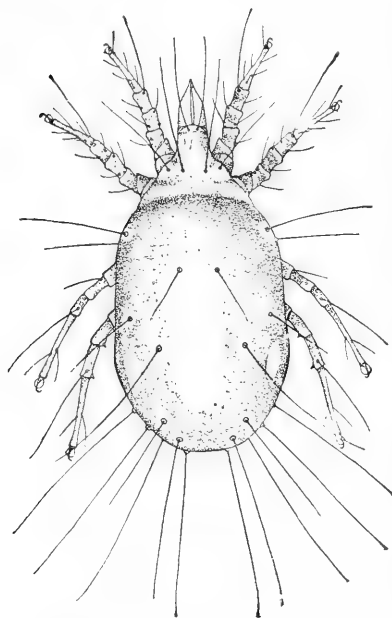


FIG. 153.—TYROGLYPHUS SP. (PERGANDE).

and often a sucker. The body is about twice as long as broad, and broadest behind the middle. There is commonly a distinction between the cephalothorax and abdomen. There are no eyes (unless certain organs in a few Hypopi are eyes). The dorsum bears a few, mostly long hairs, and the legs have scattered hairs. One hair near the end of the penultimate joint of legs I and II is very long, and there is usually a clavate hair near the base of the tarsi of legs I and II. It may be a sense organ. It is always in this position although authors sometimes figure it as arising from the preceding joint. On the venter are the usual apertures. The genital is usually elongate, and situate between the hind coxæ; there are often two U-shaped marks each side of it, known as the genital suckers. The anal opening is usually much

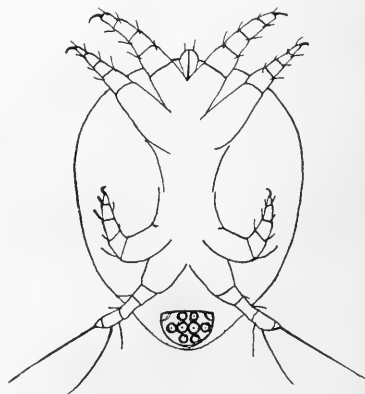


FIG. 154.—HYPOPIUS OF A TYROGLYPHUS, FROM BELOW.

before the tip; it is often but an elongate slit, with a sucking-disk each side. In *Glyciphagus* the openings are much larger, and the genital sometimes occupies the entire area between the coxæ.

The internal anatomy of the Tyroglyphidæ has been carefully studied by Nalepa and Michael. The digestive system is of the usual type; the ventriculus is very large, with two short cœca, the colon is globose, the rectum very large, and opens close to tip of body. Behind the anus is a small opening—the copulative aperture. In *Glyciphagus* the bursa copulatrix projects externally in a small cone. So in the Tyroglyphidæ, as in the Analgesidæ, copulation is not performed through the vulva, but by this special opening. This opening leads to a receptaculum seminis, which connects by a small duct to the ovaries. The nervous system is chiefly concentrated in the very large “brain” which surrounds the œsophagus. The most powerful muscles of the mite are those attached to the mandibles, the legs, and the stomach.

As a rule there is little difference in size between the sexes, but Michael has described one form with the male not half as large as the female. In several cases there are well-marked secondary sexual characters, such as the enlargement of the first or third pair of legs in the male.

The transformations of the Tyroglyphidæ are among the most marvelous of the animal kingdom. All Tyroglyphidæ (except *Carpoglyphus*) appear to lay eggs, sometimes of large size. The young on hatching are six-legged, and, molting, obtain two more. Thenceforward their life-history may take the simple and direct path to the adult condition, but often it passes through what is called a *Hypopus*. This *Hypopus* is very different from the creature from which it has developed—the octopod nymph. Its body is hard and chitinous; there is no mouth-orifice and no distinct mouth-parts. The legs are short and ill adapted to walking. On the ventral surface of the body near the tip is an area distinct from the general surface and provided with several circular marks or sucking disks. By means of these sucking disks the *Hypopus* attaches itself to an insect or other creature and is transported to some other locality, where it may find a suitable breeding place. The *Hypopus* is thus a stage in the life of *Tyroglyphus* for the purpose of migration. The *Hypopus*, on finding a suitable locality, molts into an octopod nymph, which will feed and develop into an adult mite. The causes

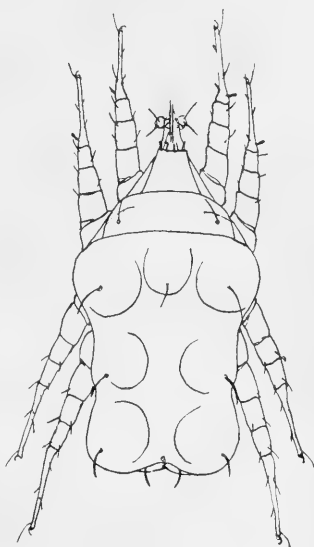


FIG. 155.—HISTIOSTOMA AMERICANA.

that will induce a nymph to transform to a *Hypopus* are not known. Mégnin supposed that the dryness of the air or the scarcity of food were necessary causes. But Michael has shown that *Hypopi* are developed in the absence of these conditions, and that the *Hypopus* is the natural and normal means of distributing the species.

In the early days of the science of acarology this connection was unknown; therefore *Hypopus* stood for a separate genus, allied more to *Gamasus* than to *Tyroglyphus*. Dujardin in 1850 concluded that *Hypopus* was the pupal stage of Gamasidæ. As investigation proceeded *Hypopus* was so frequently found in association with *Tyroglyphus* that views were advanced as to their relationship. One was that *Hypopus* was a ferocious parasite devouring the *Tyroglyphus* from within; another, that *Hypopus* was the male of *Tyroglyphus*, and a third, that *Hypopus* was the real adult of certain species of *Tyroglyphus*. The "Hypopus question" disturbed acarologists for a long time, but through the work of Mégnin and Michael it has been settled. In some species of *Glyciphagus* the *Hypopus* is not fully developed and does not escape from the nymphal skin.

Most of the *Tyroglyphidæ* differ but little in general appearance, and the characters that separate species are often few and minute. The family is usually considered to have affinity to the Sarcoptidæ and Analgesidæ, but there is more resemblance to the nymphs of the Oribatidæ; in fact, Oribatid nymphs have been described as *Tyroglyphidæ*, and *vice versa*.

The *Tyroglyphidæ* feed mostly on vegetable matter; a few live on animal food. They are partial to stored foods, and so are often of much economic interest. A long list of articles attacked by them could be compiled. It would include cheese, flour, hams, dried meats, hair in furniture, cereals, many drugs, dried fruits, seeds of all kinds, bulbs, feathers, hay, and entomological specimens. Their ravages are due to the enormous number of individuals developed from a few in a short time. Materials attacked by them are often in a few days swarming with millions of the tiny creatures. How to get rid of them is often a difficult problem. Since they have no tracheæ, they are not very susceptible to fumigation, although some of them will succumb to such treatment. Flowers of sulphur and carbolic acid are, at times, of much use. But in many cases destruction of the material



FIG. 156.—BEAK OF
HISTIOSTOMA AMER-
ICANA.

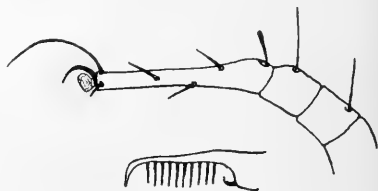


FIG. 157.—LEG I, AND TIP OF MANDIBLE OF
HISTIOSTOMA AMERICANA.

attacked is the only remedy. Since many are carried in the hypopial stage on flies, it is advisable to have the windows screened in all factories where cereals, drugs, dried meats, and fruits are prepared. When very abundant the Tyroglyphids are attacked by various predaceous mites, chiefly *Cheyletus* and *Gamasus*, which greatly reduce their numbers, and in some cases entirely destroy them.

Various species have at different times been recorded as temporarily parasitic on man, causing itching and soreness of skin. Persons handling infested products are apt to become attacked.

The genera known to occur in the fauna of the United States may be distinguished as follows:

1. Dorsal tegument more or less granulate; claws very weak, almost invisible; some hairs of body are plainly feathered; ventral apertures large..... *Glyciphagus*
Dorsal tegument not granulate; claws distinct; no prominent feathered hairs; ventral apertures smaller 2
2. Mandibles not chelate, elongate, and toothed below; body without long hairs; palpi enlarged at tip, and provided with two divergent bristles; body often verrucose..... *Histiostoma*
Mandibles chelate, not elongate; body usually with some long hairs; palpi not very distinct, not enlarged at tip, nor with the two bristles 3
3. No suture between the cephalothorax and abdomen; male lacking sucking disks near anal aperture; claws arising from a membranous plate, or else associated with bees 4
A suture present; male with paranal sucking disks..... 5
4. Body short; no clavate hair on base of tarsi I and II, a coriaceous piece on anterior margin of cephalothorax, or with a dorsal shield; living on bees, or in their nests; epimera of legs I and II not connected..... *Trichotarsus*
Body not short; with clavate hair on tarsi I and II; no coriaceous shields or pieces; epimera of legs I and II are connected; claws arising from tip of a membranous extension of the tarsus; living on dried fruit..... *Carpoglyphus*
5. Body elongate; hind pairs of legs arising much behind the anterior pairs; the Hypopus with eye-like spots..... *Histiogaster*
Body not elongate; hind pairs of legs much nearer to anterior pairs..... 6
6. No sucker at tips of tarsi; leg I never thickened; in some males leg III is thickened; tarsi with stout spines *Rhizoglyphus*
A sucker at tips of tarsi, although sometimes weak; leg III never thickened; no spines (only bristles) on tarsi 7
7. Leg I of male thickened; palpi quite distinct and separate *Aleurobius*
Leg I of male not thickened; palpi less distinct and more appressed to rostrum. *Tyroglyphus*

The Hypopi of the various genera, as far as known, can be separated by the following table:

1. A pair of clasping organs on venter near tip of body, margins not sharp-edged. *Labidophorus*
No clasping organs, but an area of suckers..... 2
2. Anterior legs end in very large claws; margins of body not sharp-edged. *Trichotarsus*
Claws small or of normal size..... 3
3. An eye-like spot each side on anterior part of body..... *Histiogaster*
No such eye-like spots 4

4. Venter behind with a submarginal crescentic plate; tarsi rather long.....*Hericia*
No such crescentic plate..... 5
5. Legs very slender, especially the tarsi; hind legs often bent forward...*Histiostoma*
Legs much shorter, the tarsi not slender 6
6. Four pairs of suckers in the plate arranged 2-2-2-2.....*Aleurobius*
Suckers not in such arrangement.....*Rhizoglyphus* and *Tyroglyphus*

Of the genus *Histiostoma* we have at least two species. The hypopial stage of one (*H. muscarum*) is often attached to house flies; the other species, *H. americanum*, was taken under bark, which was also infested with a *Rhizoglyphus*. This species has a number of humps on the dorsum of the body, and upon the summit of each is a small hair. In Europe one species lives in mushrooms, and spreads a disease that causes the decay of the

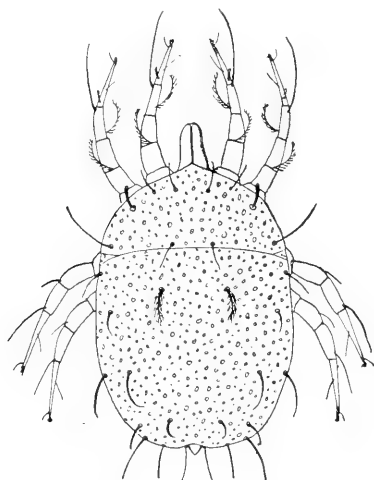


FIG. 158.—GLYCIPHAGUS OBEUS.

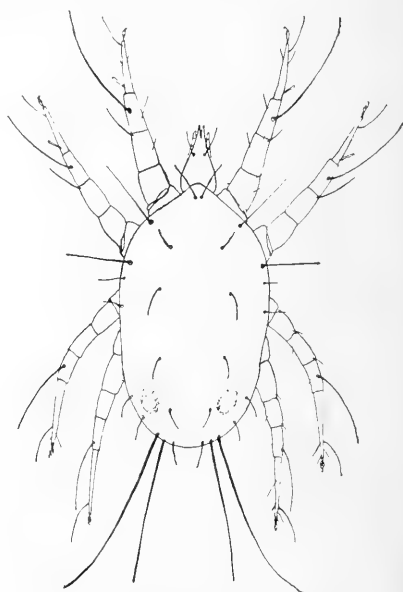


FIG. 159.—CARPOGLYPHUS PASSULARUM, MALE.

pileus. Nearly all the species occur in decaying materials, but Jensen has recorded that one species (*H. berghi*) lives parasitically in the egg-capsule of a horse-leech in Denmark. The eggs hatch into six-legged larvæ, which soon molt into the nymph. The latter devours the embryonic leech and then passes into a *Hypopus*. This escapes from the capsule, attaches itself to an insect, and, on reaching suitable locality, molts into a full-grown nymph. The latter cuts through the capsule, enters, and there transforms to the adult mite. Here reproduction takes place, and the life-cycle begins anew.

The genus *Glyciphagus* does not appear to be as common in this country as in Europe, possibly owing to their minute size. Two species are known to me, both of rather modest appearance. One has long plumose hairs on the body, and was found in seeds. In Europe several species appear to be common in houses and buildings. Some species are provided with many broad scale-like hairs. In all the forms

the skin is finely granulate, which character serves to distinguish it from all other *Tyroglyphids*. The original species of the genus (as indicated by the name) and some others have been found in sugar. The mites sometimes spread to the hands of those handling such materials, and produce a skin disease known as "grocers' itch." Michael has described two remarkable forms which he discovered in the nest of the mole. The body is broad, flat, and the margins crenulate and provided with spines. They do not occur in deserted nests, but their relation to the mole is unknown. They may, perhaps, form a distinct genus.

The curious genus *Labidophorus* has not been found in this country. The genus was based on a *Hypopus* that is found attached to moles. Michael has worked out its life history, finding that the adult is much like *Glyciphagus*. The male has several curious comb-like projections from the under side of the first and second pairs of legs, and some plumose bristles on the other legs.

The genus *Aleurobius* contains one species, *A. farinæ*, which appears to be well-nigh cosmopolitan. It is the species most commonly found in flour, grain, and stored foods. The greatly enlarged anterior legs of the male are a unique character in the family. The body has a few rather short hairs. Cleanliness, window screens, and frequent handling of the grain will be the best preventives for the protection of mills against this pest. Fumigation with hydrocyanic acid gas is the best remedy.

Tyroglyphus, the typical genus, is known in this country by three or four species, two of which are very common. One, a species in grain and stored foods, appears to be the true cheese mite, *T. siro* Linnaeus. Our specimens, however, have rather longer hairs on the body than the European specimens. Our other common species is the mushroom mite, *T. lintneri* Osborn. It is very close to the European

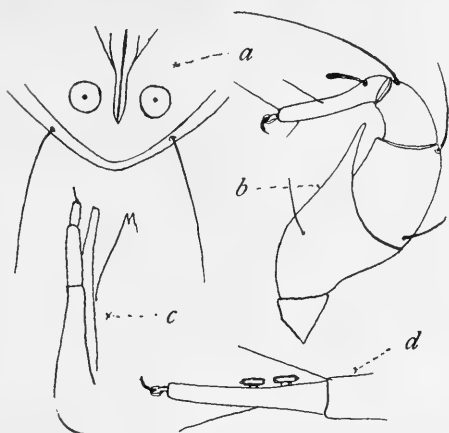


FIG. 160.—*ALEUROBIUS FARINÆ*: a, VENTER OF MALE; b, LEG I OF MALE; c, PALPUS; d, TARSUS IV OF MALE.

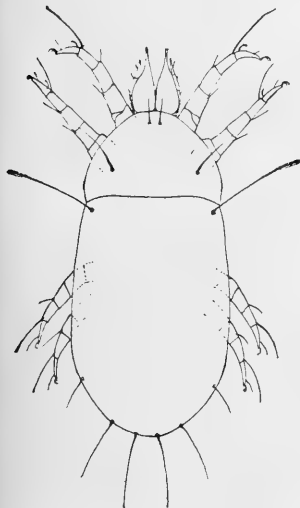


FIG. 161.—*HISTIOGASTER MALUS*, FEMALE.

in grain and stored foods, appears to be the true cheese mite, *T. siro* Linnaeus. Our specimens, however, have rather longer hairs on the body than the European specimens. Our other common species is the mushroom mite, *T. lintneri* Osborn. It is very close to the European

T. longior Gervais, but the bristles are smooth. This species at times is very destructive to cultivated mushrooms, and once in a bed it is very difficult to eradicate. Busck^a has given an account of experiments against it which serve to show the difficulty of dealing with the pest. Severely infested beds should be destroyed, and perhaps if the earth was steam-heated (as is done for root-worms), the eggs would be killed. Another species has been taken by Hubbard on oranges in Florida. It is found among the *Mytilaspis* scales, and is supposed to feed on them. Moniez has described a species, *T. wasmanni*, as occurring abundantly in nests of certain ants.

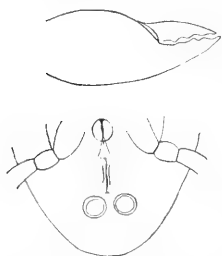


FIG. 162.—*HISTIOGASTER MALUS*, MANDIBLE AND VENTER.

The genus *Histiogaster* was based on the European *H. carpio*, and *H. entomophagus*. Our species, *M. malus*, described by Shimer and Riley, is evidently a different species. It is found on trees infested with scale insects, and particularly in company with the oyster-shell bark-louse. It feeds on the scale, possibly, however, only after the latter is dead. The body is more elongate than in *Tyroglyphus*, and the hairs are quite short. In England a species feeds within decaying reeds. The *Hypopus* of *Histiogaster* has a glassy, eye-like spot on each anterior side of the body; it may be an organ of vision, but there is no definite evidence for this view.

To the genus *Rhizoglyphus* belong a number of species, found on the ground, in decaying matter, on roots of plants, and in bulbs. The body is slightly more pyriform than in most *Tyroglyphids*, and the species are of rather large size. We have several species in the United States. One of them is the *R. hyacinthi* Boisduval (*R. echinopus* Fumouze et Robin). This is the "bulb mite" or "Eucharis

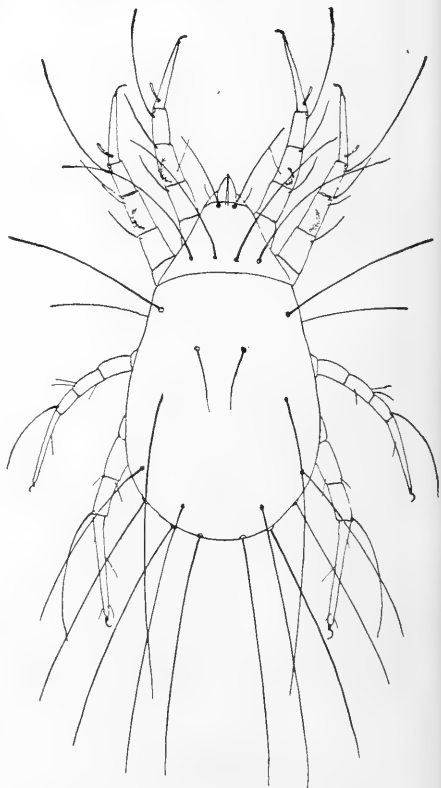


FIG. 163.—*TYROGLYPHUS LINTNERI*, FEMALE.

^a Bull. No. 38, n. s., Div. Entom., U. S. Dept. Agric.

mite" of the horticulturists, and is responsible for an enormous amount of damage. It burrows into healthy tissue, thereby giving entrance to destructive fungi and bacteria. It is especially common in hothouses, where its ravages on orchids have long been known. No one appears to have found a successful treatment. The best way is to burn the affected bulbs as soon as discovered. Some growers, however, secure good results by the following treatment: The soil of the pots of infested plants is allowed to become dry, then the bulbs taken out and washed in a solution of tobacco water and soft soap, with a small amount of washing soda. Then they are sprinkled with freshly slaked lime and left for two days. Then they are washed with the same solution as before, to which a little petroleum has been added. They are then re-potted and often do well. Mr. Woods has shown that this mite, when infesting Bermuda lilies, can not be destroyed, but much good is accomplished by the use of commercial fertilizers, and rotation of crops.

In Europe it has lately been proved that this, or an allied species, does great damage to the roots of grapevines, and that it may be destroyed by the use of carbon bisulphide injected into the soil above the infested roots.

Dr. E. P. Felt has described a species, *R. heteromorphus*, which caused injuries to the stems of carnations grown in greenhouses. We have seen the same, or closely allied species, on the roots of asparagus. Another species has been found to eat through the grafting wax on budded plants, bore beneath the bark, and so prevent the union of graft and stock. A species described by Riley, *R. phylloxerae*, was supposed to feed on the *Phylloxera*, but it doubtless fed on the grape roots.

The typical species of *Carpoglyphus*, *C. passularum*, has been found on dried figs in California. It infests dried fruit in Europe. In this genus there is no furrow separating the cephalothorax and abdomen. The position of the long hair on the tibia of legs I and II is different from that of any other Tyroglyphid. This hair is normally near the

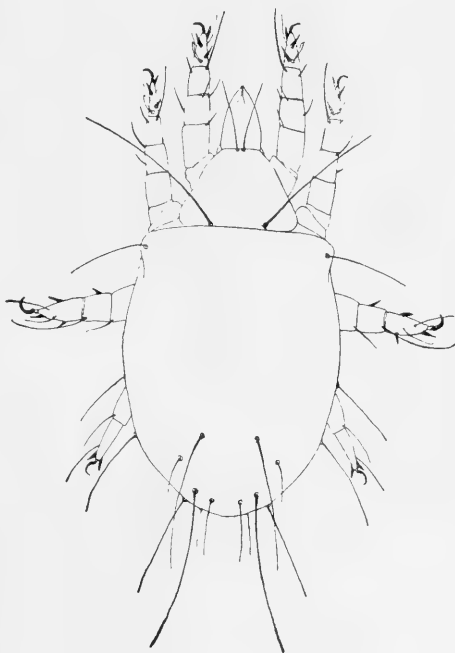


FIG. 164.—RHIZOGLYPHUS RHIZOPHAGUS.

tip of the tibia, but in this genus it arises near the middle of the joint. There are only short hairs on the dorsum of body, but at the tip are two long hairs each side. The *Hypopus* of this genus is unknown. It is claimed that the female is ovoviviparous. The species of the genus *Trichotarsus* (formerly *Trichodactylus*) are peculiar in that they occur in hypopial form on bees. They have a broad body, without division into cephalothorax and abdomen, and provided with a few short hairs. Two species, *T. xylocopæ* and *T. osmiæ*, are common in Europe, and both have been recorded from this country. The adult of one species was found in the bee's nest, and has much the appearance of the ordinary *Tyroglyphus*.

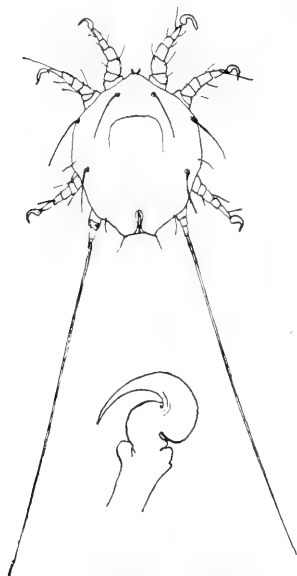


FIG. 165.—TRICHOTARSUS XYLOCOPE; NYMPH, AND CLAW ENLARGED.

The European genus *Hericia* is allied to *Trichotarsus*, and is found in the sap flowing from wounds on trees. Two other European genera, *Chortoglyphus* and *Fusacarus*, have coriaceous bodies, and the mouth-parts are not visible from above. The former has been taken in old hay and similar substances, and the latter from moles' nests.

The genus *Lentungula*, found on marine algae in England and Heligoland, is peculiar in having a slender hook-tipped process near the tips of tarsi I and II.

Family CANESTRINIIDÆ.

This family, named in honor of the famous Italian acarologist, Giovanni Canestrini, comprises only a few forms of very small size and parasitic on insects. They are related to the Sarcopidae, and also apparently to the Tyroglyphidae. The body is entire, although there is usually an indication of the transverse furrow on the dorsum. The legs are rather short, with few hairs, and terminate in a sucker like that of the Listrophoridae. The mouth-parts are small and concealed in the rostrum; the mandibles generally chelate. The palpi are simple and filiform. There are sometimes two suckers on the hind part of the venter for copulatory purposes. The dorsum bears a few hairs or bristles and some longer ones at tip. Their life history has not been investigated. Most of the species occur on beetles, some under

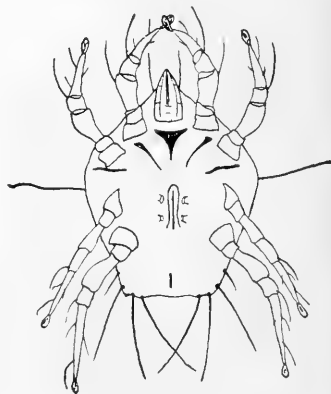


FIG. 166.—CANESTRINIA SP., FEMALE, FROM BELOW.

the elytra. One species that has been recorded from this country, *Hemisarcoptes coccisugus* Lignières, is said to live among the eggs of *Mytilaspis pomorum*. The principal genus is *Canestrinia*, represented by five or six species.

Family ANALGESIDÆ.

The bird-mites (*Sarcoptides plumicoles* of Mégnin) form one of the largest and best-known groups of the Acarina. Since the specimens can be found on the skins of birds, collections have been made in various museums, so that many species occurring in tropical countries are described—a condition not existing in other groups of mites, except the Ixodidæ. The species in the United States, however, have been but little studied. The body of an Analgesid is more or less elongate; the skin is soft and transversely wrinkled; in many forms there are finely granulate dorsal shields, one anterior, and a longer posterior one; there are neither eyes nor stigmata; there is usually a distinction between cephalothorax and abdomen. In front there is a conical projection, the rostrum; the upper part of this is known as the epistoma, and is continuous with the dorsal surface of the body. Beneath the epistoma is a pair of triangular simple mandibles, which often project beyond it. The mandibles are commonly chelate, and finely toothed at the tip. Below the jaws are a pair of maxillæ, which bear on their outer side the simple three-jointed palpi. Below this is the lower lip, and between the two is a ligula or tongue. The legs are commonly short and stout; they are arranged in two groups, the anterior pairs close to the mouth-parts, the posterior pairs toward the end of body. From their insertion on the venter there extend chitinous brown rod-like pieces, the epimera, which form a framework or skeleton for the attachment of muscles and support of the legs. The legs are of five joints, the last ending in a cup or saucer-shaped sucker or ambulacrum. Sometimes there are one or two claws. The legs bear a few hairs or bristles, in a definite arrangement. The two hind pairs of legs often differ in the two sexes, and in the male one is often enlarged or longer than the other, and used as claspers. Sometimes there are projections or apophyses on the legs. In some forms there

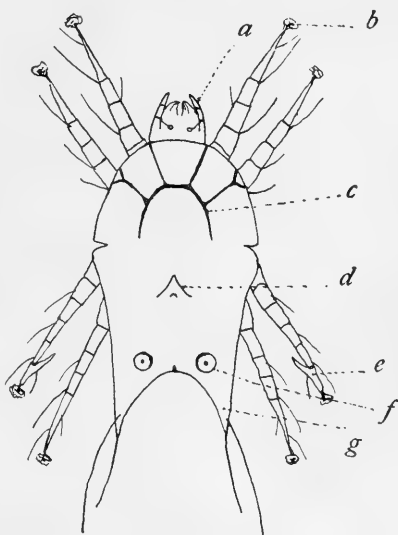


FIG. 167.—ANALGESID; *a*, PALPUS; *b*, CARUNCLE; *c*, EPIMERA; *d*, GENITAL OPENING; *e*, PROCESS; *f*, ANAL SUCKERS; *g*, LOBE.

is a backward projection from some of the basal joints of leg I; these are the olecranon processes. On the dorsum are stiff bristles, the size and arrangement of which afford good specific characters. The vulva is situated between the bases of the third and fourth pairs of coxæ; it is usually marked by a curved line, which is termed the lyra. In the male there is a smaller U-shaped mark. The copulatory opening of the female is, however, a small aperture behind the anus. The anal aperture is a simple slit at the tip of the body. Each side of it in the male there is a circular mark or sucking disk; these are the mating or copulatory suckers. The tip of the

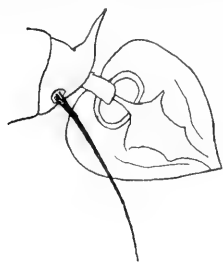


FIG. 168.—CARUNCLE OF
PTEROLICHUS.

abdomen is frequently of a different shape in the two sexes. In many genera the male abdomen is deeply bifid or bilobed at tip, while the female has the tip entire. In some forms it is more bifid in the female. In some cases the tip is provided with foliaceous plates or lamellæ. In a few genera there are two forms of the male; in one the mandibles and anterior legs are enlarged.

The development and life history of the bird-mites are replete with remarkable facts—facts which have puzzled



FIG. 169.—LEG OF ANAL-
GES; o, OLECRANON PRO-
CESS; p, TARSAL PROCESS.

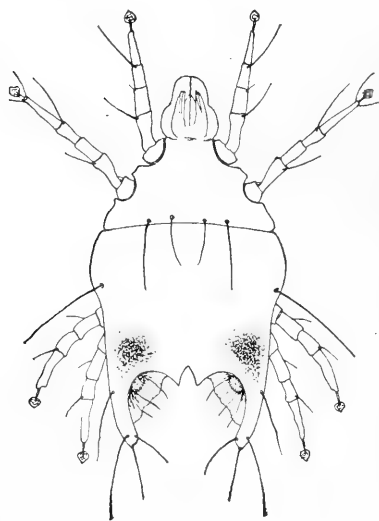


FIG. 170.—PTEROLICHUS SP. (NEAR DELIBATUS), ON CONDOR.

investigators for years, and even now not thoroughly understood. The egg is comparatively large, elongate, and slightly curved. The newly-hatched larvæ have six legs, but in some forms apparently but four. It has been claimed that it is the third pair of legs that is added when the larvæ transforms to the nymph. The nymph has the general form of the adult, but lacks the genital organs. In certain species there is a hypopial stage developed from the nymph. It is distinguished from the nymph by the absence of mouth-parts, and by having long hairs, instead of a claw, at the tip of leg IV. This stage has on the venter an area of sucking disks similar to that of the *Hypopus* of the Tyroglyphidæ. The adult male is

developed from the nymph. But in the case of the female there is a passage form between the nymph and the true adult female. It has

been called the nymphal or copulating female (*femmina accoppiata*), for it is in this stage that pairing occurs. The male mates with the nymphal female, but pairing is prolonged for several days or until the true adult female is fully developed within this nymphal female. Pairing is performed through a small aperture behind the anus, and not by the vulva, which latter is not developed in the nymphal female and only appears in the adult. The oviduct opens by the vulva. When the true female escapes from the nymphal female, an egg, already of considerable size, is seen within her body.

The Analgesidæ live upon birds, feeding on the feathers, epidermal scales, etc. They rarely do any damage to the birds, but are usually of service in keeping the skin and feathers clean. They remain on the host after death, often leaving the feathers and congregating on the skin. Although many of the species are now known from but one host, there are some common forms that occur on a considerable number of birds, frequently of different genera. Likewise several species of mites sometimes occur on the same bird.

These mites were for a long time kept in the genus *Dermaleichus* Koch, but this has been shown to be a synonym of *Analges* Nitzsch, 1818. Many other genera have been formed in recent years, and a revision of the family by Canestrini, in "Das Tierreich," in 1899, includes 31 genera and 7 subgenera. Several, however, are based on very slight characters, and do not appear advisable.

But few species have been recorded from this country. Mr. Tyrrell and Professor Haller described several from Canada, and Doctor Trouessart has taken some from American birds in the Paris museums.

In the following table I have included all known from the United States and Canada, and most of the larger genera that are apt to be found here.

1. Hind legs of the male not lengthened nor enlarged.....	2
Some of the hind legs larger or longer than the anterior legs.....	8
2. Hind legs situate more under the body, very short; the fore legs of male with processes on some of the joints, body usually quite broad.....	<i>Freyana</i>
Hind legs more lateral; legs I and II without projections in male.....	3
3. Tip of the male with foliaceous appendages; that of the female bifid, and with stout bristles.....	<i>Proctophyllodes</i>
Male without such appendages.....	4
4. Female with tip of abdomen bifid, and provided with stout bristles....	<i>Pterodectes</i>
Female with tip of abdomen entire.....	5
5. Body broad, legs very short; in male two hook-like projections from each side of the rostrum; tarsi end in claws.....	<i>Microlichus</i>
No such projections on rostrum; tarsi rarely end in claws.....	6

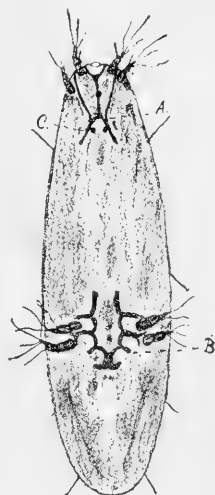


FIG. 171.—HYPODERAS COLUMBÆ, A STAGE OF FALCULIFER; a, b, c, EPIMERA (KELlicOTT).

6. Legs I and II of male longer than the others, and end in claws; two forms of male, one with very large mandibles..... *Falculifer*
 Legs I and II not longer, not ending in claws; one form of male only..... 7
7. Body soft, weakly chitinized, pale color..... *Rivoltasia*
 Body harder, more strongly chitinized; more or less brown in color..... *Pterolichus*
8. Legs I and II of male with distinct spine-like processes..... 9
 Legs I and II without such processes..... 12
9. Leg III without a sucker, ending in a stout claw; rarely spines on tarsus..... *Analges*
 Leg III with a sucker at tip..... 10
10. Leg III larger than IV, with spines on tarsus..... *Megnina*
 Leg III scarcely as thick as IV..... 11
11. Leg III plainly longer than IV..... *Protalgas*
 Leg III plainly shorter than IV..... *Pteralloptes*
12. Leg IV larger than III..... 13
 Leg IV smaller than III..... 15
13. Tip of abdomen of female entire, and usually of male; leg IV very short..... 14
 Abdomen of female and usually of male bifid at tip, often deeply so; body slender; leg IV rather slender..... *Alloptes*
14. Suckers of tarsi small..... *Xoloptes*
 Suckers of tarsi large..... *Syringobia*
15. Abdomen of male more or less bilobed at tip; leg III usually reaches beyond body, and has no teeth near base..... *Pteronyssus*
 Abdomen of male entire; leg III usually does not reach the tip of body, and has one or two teeth near base on inner side..... *Dermoglyphus*

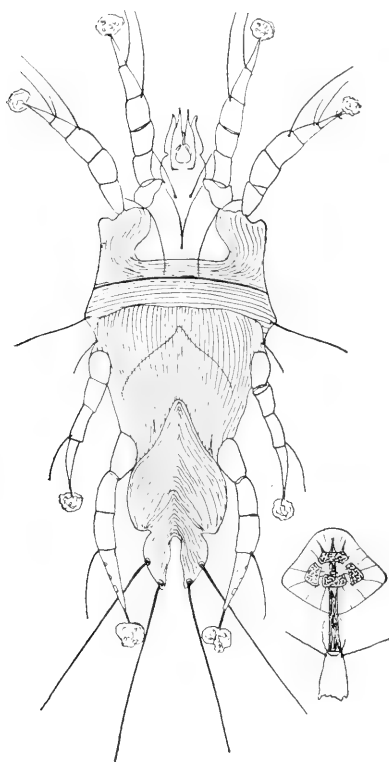


FIG. 172.—ALLOPTES MICROPHLETHON, AND CANICLE.

In *Freyana* some males have one of the anterior legs, sometimes the left, sometimes the right, greatly enlarged to aid in holding the female. The hind legs arise nearer the middle of the venter than in other genera, and are very short. Two species have been recorded from this country, one, *F. anserina* Koch, on the snow goose, and the other, *F. caput-medusæ* Trouessart, on the booby. The latter species is sometimes over 1 millimeter long, one of the largest species of the family. In *Pterodectes* the body is elongate and slender, the legs all of about equal development, and in both sexes the tip of the abdomen is bilobed, in the female with two stout bristles. There are distinct shields upon the dorsum. The genus *Allanalges* (*Pterocolus*) is scarcely different. Professor Haller recorded one species, *A. gracile-pinnatus*, from Canada.

In *Proctophyllodes* the body is also slightly elongate, and the legs of subequal size. The abdomen in the female is bifid at tip and with two

stout bristles; in the male it is scarcely bifid and provided with two prominent foliaceous appendages. *P. reticulifer* comes from California.

In *Rivoltasia* the species are rather short and broad, all legs of about equal size; the male body is deeply bilobed at tip, each lobe provided with a very long hair. They are very small species, and some occur on domestic fowls.

In *Microlichus* the species are similar to *Rivoltasia*, but the legs are shorter, and end in distinct claws, and there are two hook-like projections each side of the rostrum near its tip.

In *Pterolichus* the legs are all subequal in size. There is much variation in the shape of the body, which in the male is bilobed at tip and in the female more or less entire. It is a very large genus, and three species are known to occur in the United States. *P. aquilinus* Trouessart has been taken on the golden and bald eagles; *P. buchholzi* Canestrini on the godwit and golden

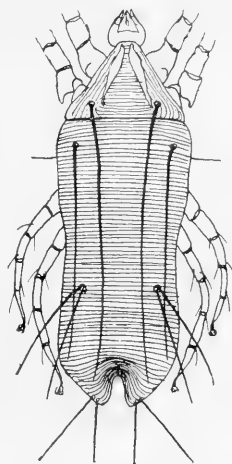


FIG. 173.—ANALGES PASSERINUS, FEMALE.

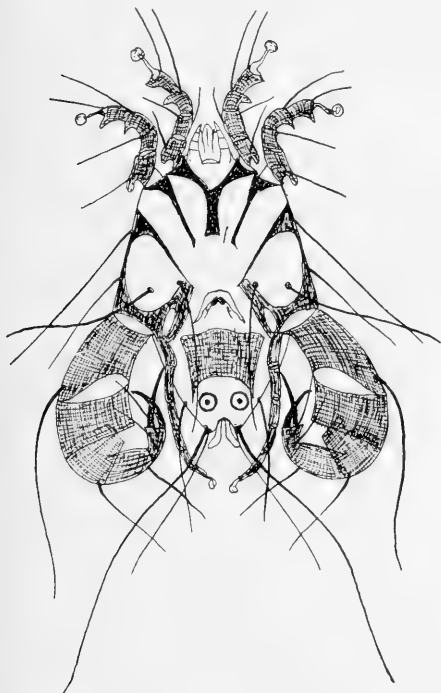


FIG. 174.—ANALGES PASSERINUS, MALE.

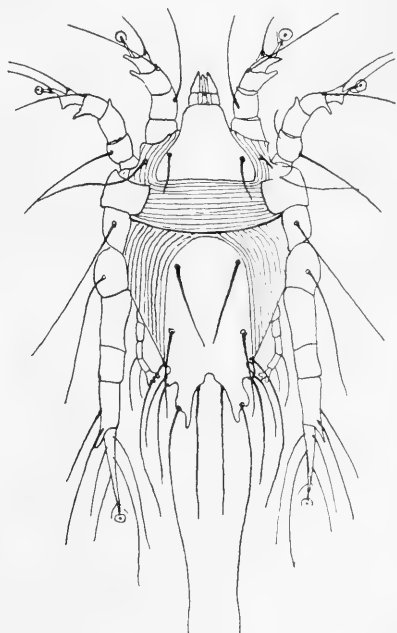


FIG. 175.—MEGNINIA TYRRELLI.

plover; and *P. longiventer* Mégnin and Trouessart on the barred owl.

The genus *Falculifer* (formerly *Falceiger*) has but few species, but one of them, *F. rostratus* Buchholz, presents several interesting points. The adult stage differs but little from the normal bird-mite, except that there are two forms of the male—one which has considerable resemblance to the female and the other which has several secondary sexual characters, the anterior pairs of legs being long and heavy and the immovable finger of the mandibles being greatly enlarged and lengthened. There is, however, an hypopial stage in the life of this mite which has been the theme of much discussion among acarologists for many years. This hypopial form was described in 1861 by Filippi as *Hypodectes* and by Nitzsch as *Hypoderas*. *Hypodectes* is found in various parts of the internal anatomy of birds, generally in the areolar

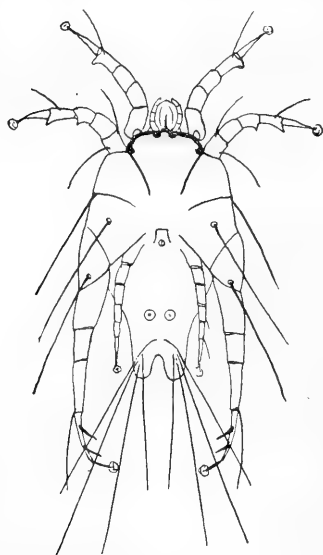


FIG. 176.—MEGNINIA ALBIDA (AFTER TYRRELL).

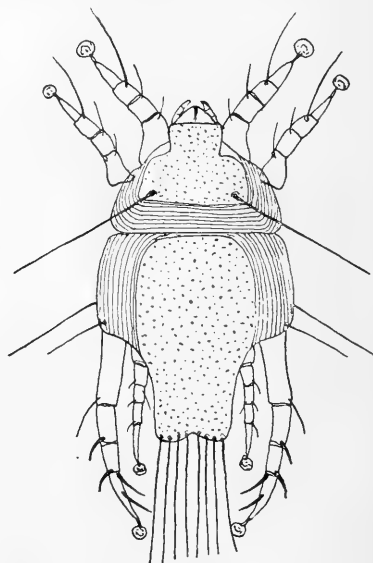


FIG. 177.—PTERONYSSUS TYRRELLI (AFTER HALLER).

and peritracheal tissues. It is of an elongate form, rounded in front and behind, and with eight short legs, two pairs in front and two other pairs toward the posterior end. There are no mouth-organs, and Slosarsky, who examined the anatomy, found no internal structures save a few muscles attached to the legs. From this it was evident that *Hypodectes* was a nymph in the state of histolysis. Mégnin soon made a more extended study, and found that the mite was a stage in the life-history of a *Pterolichus* (now placed in the genus *Falculifer*). Mégnin considers that when the *Falculifer* finds it is being deprived of shelter and food, by the birds pulling out their feathers, certain normal nymphs transform into the hypopial *Hypodectes*. This then crawls into the respiratory organs, or into the hair-follicles, burrows some distance, and there remains until normal conditions are

reestablished when it reappears on the outside. However, it is probable that more is to be learned regarding these subcutaneous forms. In this country *Hypodectes* has been taken from the pigeon and blue heron, while Mr. Beebe has recorded a similar form from various birds in the New York Zoological Park. This latter form is supposed to have caused the death of a number of birds.

In *Pteralloptes* the males have the third legs but little larger than front legs, and end in a sucker. They have usually been taken from tropical birds.

In *Pteronyssus* the male has the third pair of legs much longer than the fourth, which is very small. The tip of the abdomen is nearly truncate in both sexes, but in the male there is often some indication of two lobes. Three species have been described from Canada: *Pt. simplex*, on the red-breasted woodpecker; *Pt. speciosus*, on the sap sucker, and *Pt. tyrrelli* Canestrini (*fuscus* Tyrrell), on the white-breasted swallow. *Megninia* is similar to *Pteronyssus*, but there are several spines near the tip of the third legs, and the tip of the male abdomen is distinctly bifid. They are usually brown in color, and many species are known. Several are described from our birds, as follows:^a *M. aculeatus*, on the blue jay; *M. tyrrelli*, on the cat-bird; *M. gladiator*, on the wild pigeon; *M. forcipatus* on sand-pipers; *M. pici-majoris*, on the big sap-sucker, and *M. albidus* on the white-breasted swallow. In *Analges* the male has the third pair of legs not only longer than the others, but usually very much enlarged in the middle, sometimes enormously so. On legs I and II there are one or two spur-like projections from the tibiae and tarsi, and on the base of the femur there is a reflexed spur, the olecranon process. The tip of the male abdomen is often pointed, and never deeply bilobed; the female has a rounded tip and elongate body. The tarsal suckers are smaller than in *Megninia* and *Pteronyssus*. Five species have been described from American birds: *A. tyranni*, on the king-bird; *A. longispinosus*, on the snow-bunting; *A. tridentulatus*, on the horned lark; *A. cremidonotus*

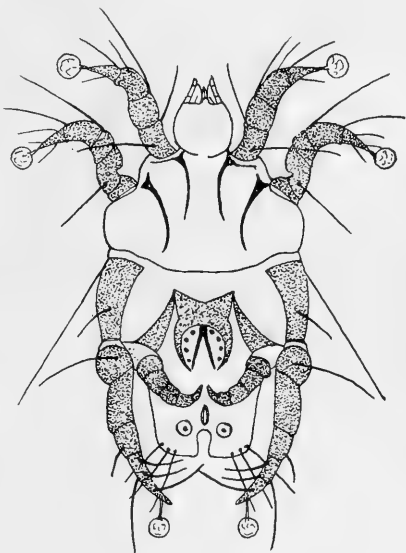


FIG. 178.—ALLANALGES GRACILEPINNATUS.

^aSeveral of these species, namely, those described by Prof. Haller in the Zeitschr. f. wiss. Zoologie, 1882, are not mentioned in Prof. Canestrini's treatment of the world species in Das Tierreich, Lief. 7, 1899.

Trouessart from California; *A. digitatus* Haller, on the Canadian warbler; and the European *A. passerinus* Linnaeus recorded from several small birds.

Family LISTROPHORIDÆ.

The members of this family (*Sarcoptides gliricoles* of Mégnin) are closely related to the bird-mites, but live upon many of the smaller mammals, including bats. They are small, soft-bodied, and with short



FIG. 179.—SCHIZOCARPUS MINGAUDI, FEMALE, SIDE VIEW.

and stout legs, terminating in a sucker and often a slender claw. The body usually tapers a little behind, and the legs are widely separate, one from the other, sometimes each pair is at an equal distance from the adjoining ones. The dorsum has a few short hairs, with longer ones at tip. The surface is usually transversely striate. The rostrum or beak forms a distinct cone on the front of the body; the palpi are simple, filiform, and lie close to the underside of the beak; they are three-jointed. The mandibles are commonly chelate, but very small. The genital apertures are situate between the third and fourth coxæ, and the anus at the tip of the body. The males, which are usually of a different shape than the females, have a pair of copulatory suckers near the tip of the venter.

These mites feed on the hairs of small mammals, and each genus has some special apparatus wherewith to hold onto the hair. In *Listrophorus* the under lip is expanded on each side into a flexible plate which curls around the hair. They occur on rabbits, squirrels, and mice. In *Myocoptes* the hind pairs of legs are enlarged, the apical joints provided with a few large spurs, and these joints can fold back on the basal joints as a knife-blade. By this arrangement they cling to the hair of mice. In *Trichacius* the hind tarsal joint is flattened, curved, and provided with a spine, which enables the mite to grasp the hair of mice. In *Labidocarpus*, which occurs on bats, the anterior legs are very short and the last joint enlarged and concave below. By these they clasp hairs. The hind legs are normal. *Schizocarpus* has a similar arrangement; it occurs on the beaver. In *Chirodiscus* the anterior legs have the apical joints flattened and curled, but destitute of claws and sucker.

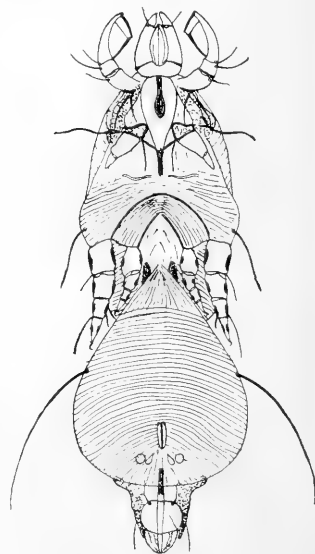


FIG. 180.—SCHIZOCARPUS MINGAUDI, MALE AND FEMALE TOGETHER.

Little is known regarding their life history. In *Labidocarpus* the male mates with a nymphal female (as in the Analgesidæ), which moults, and the true female issues only to deposit eggs. Some species of *Listrophorus* are preyed upon by a species of *Cheyletus* that uses the rabbit's fur as a hunting forest.

This family is based on the pilicolus habit and the possession of some apparatus to cling to the hair. Since this apparatus is very different in the various genera it has been surmised that the family is not a natural one, but includes forms really belonging to the Analgesidæ, Tyroglyphidæ, and Sarcoptidæ.

The American forms, with the exception of *Schizocarpus mingaudi* on the beaver, have not been investigated. That species is, however, very peculiar in many ways. The male has the third pair of legs large, the fourth very small, and mates with a nymphal female, which possesses but one pair of legs. The adult female is of normal appearance. It has been taken in Texas, California, and Washington, and also occurs in Europe.

Labidocarpus has an elongate, tapering body, annulate with many narrow ridges, and at once reminding one of the Eriophyidæ, to which there is, doubtless, some affinity.

Family SARCOPTIDÆ.

The itch mites (*Sarcoptides psoriques* of Ménézin) have long been familiar through their disgusting parasitism of the human subject. They often burrow within the skin of man and other mammals, and thereby produce intense itching, and a diseased condition known as scabies, mange, or more properly acariasis. The mites are very small, white, and semiglobular in shape. The body is entire, and the surface transversely striated and provided with a few bristles, often short, stout, and sharp-pointed. The legs are short and stout, arranged in two groups. The anterior legs are usually larger than the others. The tarsi commonly terminate in a stout claw. There is generally a long pedicellate sucker, sometimes with a jointed pedicel. The claw or sucker may be absent and in its place a long bristle. The legs often show a chitinous framework of rings, both transverse and oblique. On the front of the body is a prominent beak. The palpi are small, three-jointed, and appressed to the sides of the beak beneath.

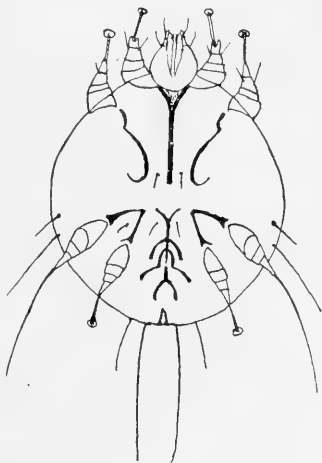
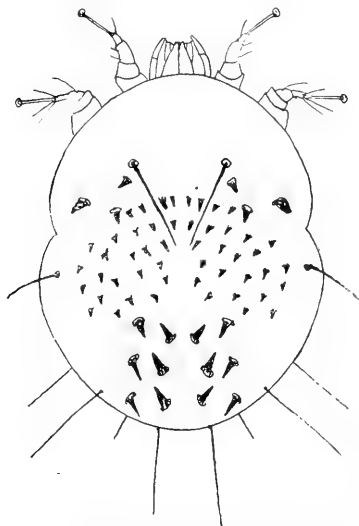
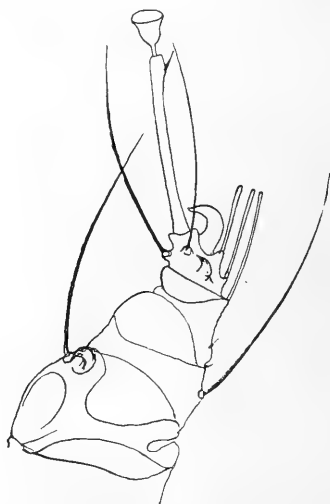


FIG. 181.—*SARCOPTES HOMINIS*, MALE.

The mandibles are chelate^a and vary in length with the genus. The ventral openings are in the usual position, and in the male there is often a pair of copulatory suckers near the tip. There are frequently sexual differences; some males have the third pair of legs very large and long, while the fourth pair is very small. Sometimes there are plate-like lobes at the tip of male abdomen, and the tarsi may terminate differently in the two sexes. The Sarcoptidae live in the skin of mammals, including man and a few birds. The female burrows into the skin, depositing eggs on the way. The young, on hatching, start burrows of their own, so that a host is infested in patches. These burrows or cuniculi are close to the surface, and sometimes result in loosening pieces of the epidermis so as to produce a scaly effect or

FIG. 182.—*SARCOPTES HOMINIS*, FEMALE.FIG. 183.—LEG OF A *SARCOPTES*.

crust. Frequently there are vesicles, papules or pustules, which may become ulcerated by scratching. The different species produce different effects, and even the same species when on different animals. When upon a hairy animal, the hair usually falls out in the affected portions. The young *Sarcoptes*, when newly hatched, has but three pairs of legs; the last ending in a long bristle; and there are no chitinous bands. Some species moult four times before maturity. When adult they pair, and the female wanders a little in search of a good burrowing place. At this time the mites can exist for a long period if removed from their hosts and kept in a moist situation; but if exposed to dryness, they soon die. The burrow is made by eating

^aFürstenberg in his great work, *Die Krätzmilben der Menschen*, figures two pairs of chelate mandibles; this is a manifest error, and weakens one's faith in his fine figures.

the tissue, and is of the size of the mite. As the female progresses she leaves behind her a row of from ten to forty large eggs and a considerable amount of “frass.” The female, having deposited her complement of eggs, dies at the end of her burrow. As the skin of the host is always wearing off, and constantly being renewed from below, the eggs, when ready to hatch, will be close to the surface, so that the mites may readily escape. Above each burrow there is often a little pimple, containing a watery fluid. There appears to be no

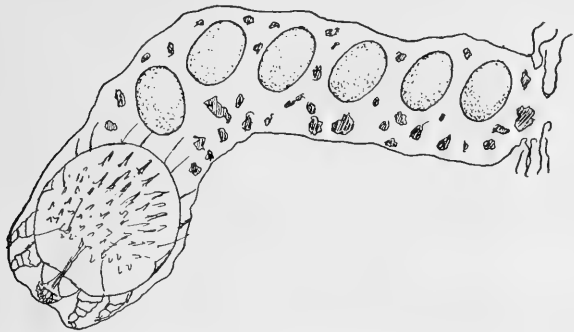


FIG. 184.—SARCOPTES IN HER BURROW, AND EGGS.

means of distribution from individual to individual except by contact. Many of the species that are normally confined to one host can live on other animals and on man. The eggs if kept moist may retain their vitality for a week.

There are but a few genera; the better-known ones may be tabulated as follows:

1. Anal opening on the dorsum	2
Anal opening below	3
2. On small mammals, not bats; third pair of legs in male without apical suckers.	
<i>Notoedres</i>	
On bats; third legs in male with suckers	<i>Prosopodectes</i>
3. Pedicel of suckers jointed; mandibles styliform and serrate near tip.....	<i>Psoroptes</i>
Pedicel not jointed; mandibles chelate	4
4. No suckers to legs of females; parasitic on birds.....	<i>Cnemidocoptes</i>
Suckers at least on legs I and II; parasitic on mammals	5
5. Legs very short; in male the hind pairs equal in size; body usually short.	<i>Sarcoptes</i>
Legs more slender; in male the third pair is much larger than the fourth; body more elongate.....	6
6. Female with suckers to fourth pair of legs.....	<i>Chorioptes</i>
Female without suckers to fourth legs.....	7
7. Hind part of male abdomen with two lobes.....	<i>Caparinia</i>
Hind part of male abdomen without lobes.....	<i>Otodectes</i>

Sarcoptes includes the species parasitic on man, although some others may also occur. The human species is *S. scabiei*. This pest was formerly more common than now, particularly in armies. The intolerable itching caused by the presence of these mites leads to wild and

incessant scratching, which only serves to spread the infection and increase the inflammation. Cleanliness is the best preventive. The

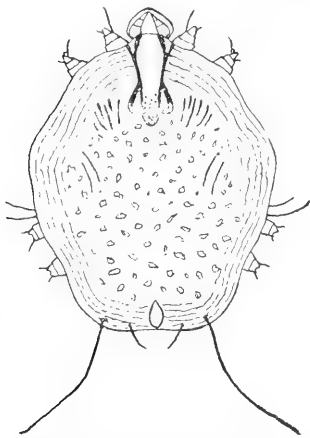


FIG 185.—CNEMIDOCOPTES MUTANS, FEMALE.

best remedy is the use of an ointment containing sulphur. If the affected parts are freely bathed in hot water and soapsuds the scaly portions of the skin will be removed, and then the ointment can be applied with a certainty of reaching the mites. The application should be repeated two or three times, each a few days apart, in order to kill any mites that may have hatched since the first application. All underclothes and bedding should be washed in boiling-hot water. The Norwegian itch mite is *S. scabiei-crustosæ*; it produces a coarse leprous crust infested on the inner surface with myriads of the mites. It is much less common than the other species.

Nearly all of the domestic animals may harbor a species of *Sarcoptes* peculiar to them. The more common are those of the hog, horse, and sheep. They work like the human species, and are amenable to the same treatment, or that used for sheep-scab. The species of the genus *Psoroptes* have piercing mandibles, and do not burrow. One species, *P. communis* var. *ovis*, is the cause of sheep-scab, a serious disease of this animal throughout the world. The fleece of scabby sheep presents a rough appearance, the wool in places being stuck together in greasy masses. The mites are most abundant around the edges of an infested patch, and increase very rapidly. The eggs hatch in two or three days, and in fifteen days they become mature. The female lives for several weeks and deposits a great number of eggs, commonly in patches of about twenty each.

By rubbing against posts, trees, and fences wool containing mites and eggs is removed which may infect healthy sheep rubbing against the

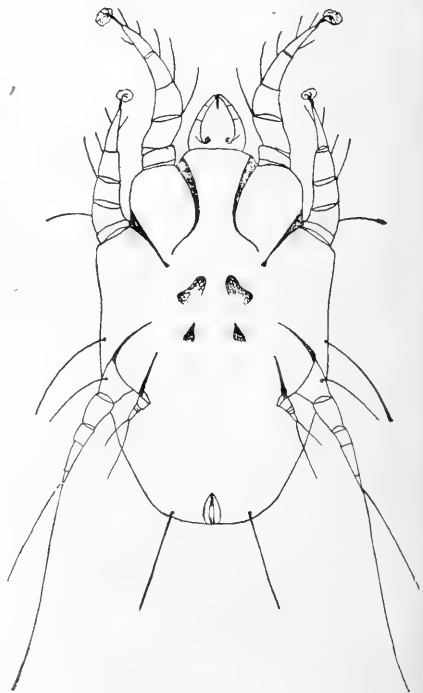


FIG. 186.—OTODECTES CYNOTIS, FEMALE.

same places from other causes. The loss is usually heaviest in autumn and early winter. Sheep if not treated may soon become so enfeebled through fatigue and lack of rest as to die. The best remedy is to dip the sheep in some poisonous solution. Various dips are in use, mostly based on tobacco, sulphur, tar, or lime. The famous Rutherford dip, which has been very successful, is prepared by using one pound of tobacco, one pound of sulphur, and four gallons of water. The tobacco is steeped for some time in the water, the sulphur is added to this tobacco water, and then the mixture is diluted by the requisite amount of water. It is best used warm. It is customary to give another dip about six or eight days after the first, so as to catch the mites that have hatched since the first dip was applied. Gillette has used an 1 per cent kerosene emulsion, and considers it

cheaper than anything else. It is said that in Europe shepherds apply a salve containing mercury and oil of turpentine. If the sheep have been kept in stables, these should be cleaned, the surface soil removed, and the woodwork whitewashed to a height of four feet.

The species of *Chorioptes* do not burrow in the skin, but produce a scab similar to sheep-scab; but it is restricted to certain parts of the animal, as the feet, the ears, or neck. They are amenable to the same treatment as the *Psoroptes*. Species occur on the horse, ox, sheep, and goat. The genus *Notoedres*, differing from *Sarcoptes* in the dorsal anus, occurs on cats and rabbits. *Prosopodectes* is limited to bats, and burrows in the tissues of the ears. *Caparinia* occurs on a few wild animals, and *Otodectes* lives in the ears of dogs and cats; *O. cynotis* Hering has been taken in this country. Animals may be so tormented by these parasites that



FIG. 188.—*PSOROPTES COMMUNIS*, VAR. *OVIS*, FEMALE AND CARUNCLE ENLARGED.

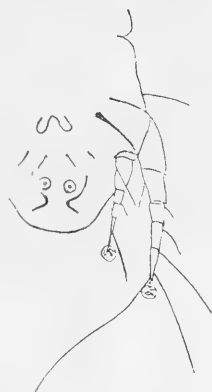


FIG. 187.—*OTODECTES CYNOTIS*, TIP OF MALE ABDOMEN, AND HIND LEGS.

they have convulsions or fits. The purulent matter should be carefully removed, and the ears bathed and injected with olive oil containing one-tenth part of naphthol.

The genus *Cnemidocoptes* contains a number of species that occur on various birds, including poultry. Some live at the base of the

feathers, others produce a crust of loosened tissue and dead skins similar to that of Norwegian itch. They may begin on the comb or skin of the feet, but gradually spread down the neck or up the legs. The species are all short and broad, with short legs and with very few hairs above, and these small. They give birth to living six-legged larvæ, which, however, appear to have hatched from eggs while in the body of the parent. *C. mutans* Robin is the itch mite of domestic fowls, at times a very serious pest. The disease it produces is known as "scaly leg," since the mites are most abundant on the legs. The best remedy is to soak the legs in warm soapy water until the crusts are loosened; then apply sulphur ointment. Bathing the affected portions in a 5 to 10 per cent solution of creolin is also a good remedy; the treatment should be repeated in a few days. The infested fowls should be isolated until cured. Another species, *C. gallinæ* Railliet, occurs at the base of the feathers, where it burrows and produces a mass of loosened scales. The itching induces the hens to pluck their feathers.

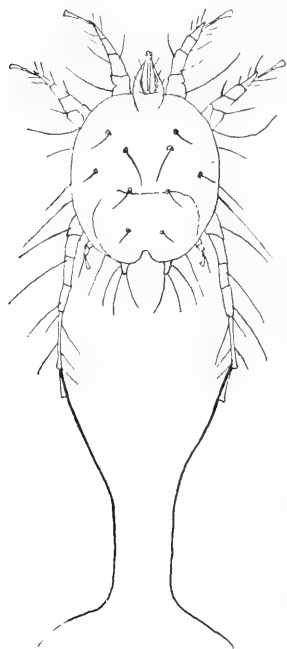


FIG. 189.—*PSOROPTES COMMUNIS*,
VAR. *OVIS*, MALE.

Family CYTOLEICHIDÆ.

This family (*Sarcoptides cysticoles* of Mégnin) contains but two species—*Cytolichus* (formerly *Cytodites*) *nudus* and *Laminosioptes* (often *Symplectoptes*) *cysticola*—both of economic importance. They were discovered in 1870 by Francesco Vizioli in the common fowl. Both are very small, soft-bodied mites, much like a *Sarcoptes*, but differing in having the vulva longitudinal and the smaller and less prominent mouth-parts. The legs are very short, the anterior pairs the larger, and all separate at base. The tarsus ends in a long sucker, but without claws. *Laminosioptes* sometimes occurs on the skin, but often bores into the subcutaneous tissue, where it gives rise to a calcareous cyst. *Cytolichus* has been found in various parts of the common fowl, but most commonly in the air-passages and air-cells. Here its presence in

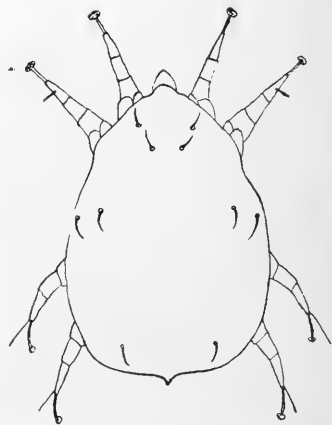


FIG. 190.—*CYTOLEICHUS NUDUS*.

great numbers may produce asphyxia in the host. It has also been suspected of producing peritonitis and enteritis, but Wilcox has shown its presence in perfectly healthy fowls, so that it is not certain that the mite necessarily produces any disease. The mites are probably taken up by the fowl with its food. Although apparently clumsy the mite is exceedingly active, and can penetrate most of the tissues of the body. It is viviparous, and the young at birth have six legs. They also occur on most of the birds related to or associated with poultry. Both species have been taken in this country, but *Cytotoleichus* is the more common.

Family ERIOPHYIDÆ.

The members of this family, long known as *Phytoptidæ*,^a are among the most curious forms of the Acarina. They are extremely minute, but make up by their great numbers. They are strictly plant-feeders, and many of them cause galls, fuzzy spots, or other deformations on plants. These galls, unlike many insect galls, have an opening through which the mites may pass. The adult mite has but four legs, all near the anterior part of the body; the posterior pairs being wholly lacking or represented by fine hairs. The body is divided into two parts—the anterior, short and broad, is the cephalothorax; the posterior, long, tapering, and multi-annulate, is

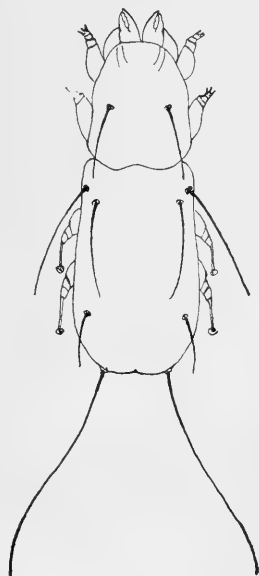


FIG. 191.—*LAMINOSIOPTES CYSTICOLA*.

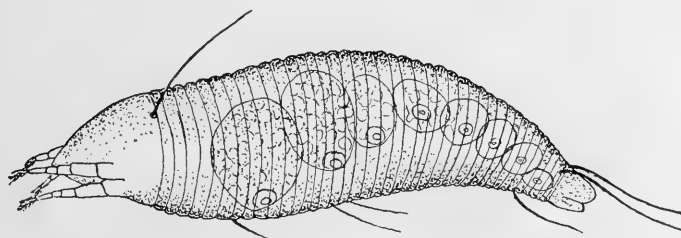


FIG. 192.—*ERIOPHYES* SP., SIDE VIEW

the abdomen. There is a pair of free three-jointed palpi, and between them the rostrum, from which may project the needle-like mandibles.

^aThe change of name of this well-known group of mites seems inevitable, although much to be deplored. *Eriophyes* Siebold has a year's priority over *Phytoptus* Dujardin. But Siebold did not carefully study these mites at all, and supposed them to be immature creatures. Dujardin recognized their true nature and made many careful observations upon them. European authors, however, have recently adopted *Eriophyes*.

Near the base of the abdomen, beneath, is the genital opening, the female epigynum being quite large and prominent; the male epiandrum is much smaller. At the apex of the abdomen is a truncate piece, the telson, from which arise two long hairs, and sometimes other shorter ones. There are also a few other hairs on the body. At the tip of the abdomen is a sucker, which can be extended or retracted at the will of

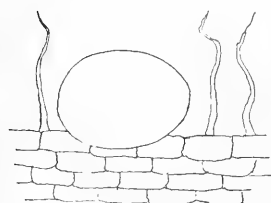


FIG. 193.—EGG OF AN ERIOPHYES
IN GALL.

the animal. The legs are five-jointed, short, and end in a single tarsal claw, beneath which is a plumose hair, known as the "feather hair." The cephalothorax often shows various lines or ridges. The number of rings or annulations on the abdomen varies according to the species, and in some forms there are more divisions above than below. In size few of the Eriophyidae reach one-hundredth of an inch, and many are not half as long.

The Eriophyidae have had a checkered history. The early botanists, unable to see the minute creatures, supposed that the galls and fuzzy spots were fungi, and so described them, the genus *Cephaloneon* being founded on distinct galls, *Volvolifex* on rolled edges of leaves, and *Erineum* and *Phyllerium* on the fuzzy patches.

Dugès in 1832, who was the first to carefully look into these galls, supposed that the mites were immature, since they had but two pairs of legs. He saw the eggs, but supposed that the adult mite had come in the gall to lay the eggs and then went out to deposit eggs elsewhere. In 1851 Dujardin examined some galls, found the mites, and noticed within some of these, objects which he took to be eggs. Therefore he believed these mites to be adults, and named them *Phytoptus*. A few years later Scheuten examined the pear-leaf blister, found the mites, and decided that they were immature forms, and that the full-grown creature was an eight-legged mite that he found associated with them. This supposed adult he figured and proves to be a Gamasid, which was doubtless feeding on the *Eriophyes*. Since then many observers have examined these mites and confirmed Dujardin, that they are adult and constitute a separate group of Acari.

The deformations produced by mites on plants have been called *acarocecidii*. Nearly all such deformations are produced by members of this family. The relation of the mite to the gall or erineum is not fully known. An erineum is practically a dense mass of deformed

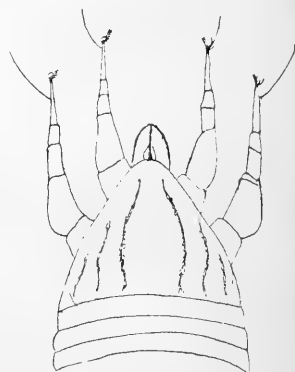


FIG. 194.—ERIOPHYES GOSSYPHII, AN-
TERIOR PART OF BODY.

hairs. These hairs are usually thickened and twisted, and the whole mass is of an even height. The mites live among these deformed hairs, sucking the juices of the leaf. As the juice becomes exhausted the erineum becomes reddish or rusty brown in color, and is a very prominent object. At this stage, when the erineum is most easily noticed, one is apt to find few if any mites, as they have left for fresh pastures.

The galls may be on either surface of the leaf, though commonly above. The form is quite characteristic of the species, though there is usually some variation. These galls always have an opening through which the mites can pass. This character will distinguish these galls from those of *Diptera* and *Hymenoptera*, but not from Homopterous galls. The opening is often very small and concealed by tufts of hairs. Within, the gall is often partly filled up with folds and projections, and sometimes with hairs. In color the gall is at first like the leaf, but gradually turns yellow or reddish, and then brown or black. Sometimes the gall covers a great deal of space, but does not swell up much, in appearance much like a blister.



FIG. 195.—NAIL-GALLS OF AN ERIOPHYTES.

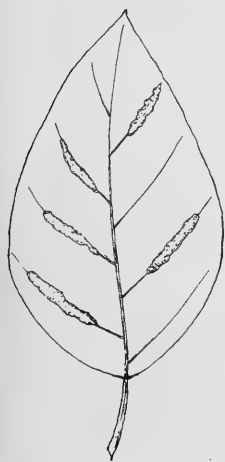


FIG. 196.—RIB-GALLS OF AN ERIOPHYTES.

Galls are formed while the leaf is growing rapidly. It is supposed that the puncture of the plant-cells by the mite induces an increased flow of sap in that direction, which causes the spot to grow faster than the surface around it, so that this spot must swell up in the form of a gall. This, however, does not account for the diversity of form of the galls, and why each gall is characteristic of the mite that made it. Some species of *Eriophyidae* live in plant-buds, and their feeding prevents the opening of the bud, which after a time dries up and dies. With other species the buds swell to a great size, but never open. Other mites produce a curling or rolling of the edge of the leaf, or a slight folding of the surface. Some live on the surface of fruits, as the orange-rust mite. A few species produce galls or excrescences on twigs, especially near the base of terminal buds.

The diseased condition produced by these mites has been termed *phytoptose* or *erino*se.

The eggs of the *Eriophyidae* are laid upon the surface of the leaf.

They are attached singly, are nearly spherical in shape, and pale yellowish or grayish in color. The eggs are quite large as compared with the mite. The young, at birth, are helpless and without tarsal appendages, but soon molt and obtain them. The mites can move quite swiftly, considering their size, and sometimes they spread over a tree with wonderful rapidity. The anal sucker aids them in holding on to a surface, but not in locomotion. They molt four times, it is said, before becoming adult, but pass through no changes in structure, except the development of the genital apertures. At each molt there is a resting period when the mite is within its old and now loose skin. With the drying up of the food-plant in the fall the mites seek winter quarters within the buds or beneath the bud-scales. Sometimes, doubtless, they winter under pieces of bark. When in a bud they begin to feed on the leaf, and produce the gall before the bud is fully open.

The Eriophyidae have usually been supposed to have some affinity with the Sarcopitidae; however, I think they show far more relation to the Tarsonemidae and Tyroglyphidae. There is not much diversity of form in the family, and generic classification is based on few and rather simple characters. Quite a number of galls have been collected in the United States, but the mites have not been studied except by Professor Garman, who described a few species. Several European acarologists have carefully studied these mites in recent years, but the work of Alfred Nalepa, of Linz, has been preeminent.

The better-known genera maybe separated as follows:

- | | |
|-----------------------------------------------------------------------------------|---------------------|
| 1. Number of abdominal rings on dorsum and venter nearly equal..... | <i>Eriophyes</i> |
| Number of abdominal rings on venter nearly twice as many as on dorsum..... | 2 |
| 2. Dorsum with the middle area highly arched..... | 4 |
| Dorsum of an even curve..... | 3 |
| 3. End piece of abdomen plainly separated..... | <i>Anthocoptes</i> |
| End piece of abdomen not plainly separated..... | <i>Phyllocoptes</i> |
| 4. Some of the dorsal abdominal rings extend backward spine-like on the side..... | <i>Oxypleurites</i> |
| Dorsal rings not so..... | 5 |
| 5. Dorsum of abdomen with two longitudinal furrows..... | <i>Epitrimerus</i> |
| Dorsum without furrows..... | <i>Tegonotus</i> |

The species, so far known from the United States, have been referred to *Eriophyes*, but several of the other genera occur here.

Most notable of all our species is the pear-leaf blister-mite, *Eriophyes pyri*, an European species whose introduction into this country seems to have been accomplished before 1870. It is now widely distributed throughout most of the pear-growing region, and also occurs in Australia. It appears to be more injurious in this country than in Europe, and in some cases it is so abundant that the tree sheds nearly all its leaves before the fruit is ripe. The mites pass the winter in the buds, and begin to feed before the leaves are

unrolled. They form red-blister-like spots nearly one-fourth inch across. These spots become green by June, and then turn brown, and the tissue becomes hard and corky. The opening is on the

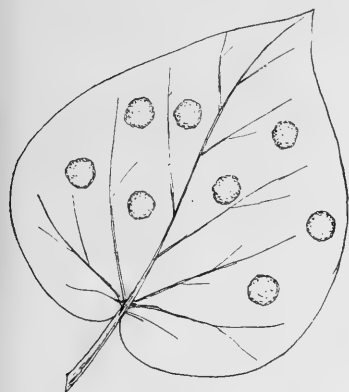


FIG. 198.—ROUND-GALLS OF AN ERIOPHYTES.

reaches the hibernating mites in the buds, and kills them there.

Another species of considerable economic importance is *Eriophyes oleivorus* Ashmead, the rust mite of the orange and the silver mite of the lemon. It occurs in Florida and California, and lives on both leaves and fruit. On the foliage the mite causes the leaves to become curled and lose their gloss. On the fruit of the orange the mite produces a hardening of the rind, which becomes brownish in color. The infested orange, although injured in appearance, is better able to stand long shipment, and more juicy than the clean fruit. Upon the lemon the mites cause the rind to become whitened or silvered. The fruit is better for shipment, but the rind is injured for commercial purposes. The circular eggs are deposited on the leaf or fruit, generally in clusters. They hatch in five to ten days. It takes about two weeks to reach maturity. Its food is the essential oil, found in the epidermal cells. Mr. Hubbard, who studied this mite more carefully than anyone else, estimated that there may be 75,000 mites and eggs on a single leaf. The best remedy is flowers of sulphur; this may be applied dry, or mixed in with a spraying solution, as kerosene emulsion.

Another injurious species in this country is the plum-twig gall mite, *Eriophyes phloeocoptes* Nalepa (also known as *Cecidoptes pruni* Amerling).



FIG. 197.—SECTION OF AN ERINEUM ON LEAF.

under side. As mites often start galls close together, they soon coalesce and form large blotches. Professor Slingerland has found that they can be practically exterminated by spraying the trees in winter with kerosene emulsion diluted with from five to seven parts of water. This mixture

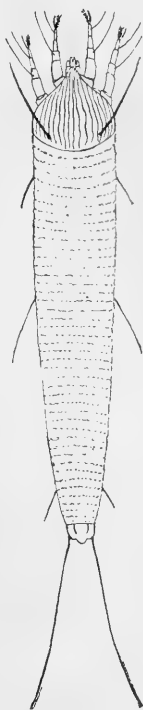


FIG. 199.—ERIO-PHYES VITIS.

It is an European species that has been imported into this country in recent years. The mites form small subspherical galls at the base of the buds. A cluster may surround the twig. The mites hibernate within the galls, leaving them in the spring to form new ones. The galls are at first plump and smooth, but later become dry and wrinkled, and sometimes crack. Pruning and burning the infested twigs in winter will keep the mites in check. An application of sulphur in the spring, when the mites are active, will, doubtless, destroy many of them.

The black-currant gall mite, *Eriophyes ribis*, is very injurious to the currant in England. They penetrate the buds, causing them to swell, and badly infested buds die before opening. The mites breed

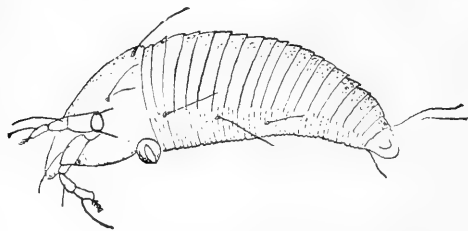


FIG. 200.—*PHILAEOCPTES* SP., SIDE VIEW.

throughout the year. They migrate in the spring when the buds are opening, and may be destroyed at this time by a wash of soft soap and sulphur. It has been observed that this species can stand upright and even jump into the air and be carried some distance by the wind.

In California the *Eriophyes vitis* Landois often seriously injures the leaves of the grape. The mites produce an erineum on the under surface of the leaf that causes swellings on the upper surface.

The mites pass the winter in the buds or under the bark of the vine. Applications of sulphur will destroy this as well as other species of *Eriophyes*. Walnut trees in California are also affected by an *Eriophyes* which produces blister galls and erineum on the leaves. It appears to be the *E. tristriatus* Nalepa, of Europe, which has similar habits.

One of our most common species is *Eriophyes quadripes* Shimer, which produces roundish galls on the leaves of the soft maple. The galls are at first green, but later become purplish and finally black. There are often several hundred galls on one leaf.

Eriophyes gossypii Banks occurs injuriously upon cotton in Montserrat and some other West Indian islands. The mites produce galls which were so numerous as to cover many leaves with a mass of irregular, roughened swellings, curled and distorted. The damage in places was so severe that the cotton had been thrown into the sea. The galls within are densely clothed with long hairs.

Two species are very injurious to the leaves of the tea plant in India and Ceylon, and no good remedies have yet been devised for them.

Family DEMODECIDÆ.

To this family belongs but one genus, *Demodex*, found in the sebaceous glands and hair-follicles of various mammals, including man. The mite is very small, elongate, with eight short, three-jointed legs, and in front a short, median, sucking rostrum. The palpi are appressed to the under surface of the rostrum. The abdomen is tapering, transversely striate above and below, and rounded at tip. There is a large vulva situate at base of the abdominal venter. The egg is fusiform, and gives birth to a hexapod larva, which moults and becomes octopod. Two more moults brings it to maturity. The nymphs greatly resemble the adults, and the sexes differ but little.

D. folliculorum Simon, the species found on man, was long supposed to be the cause of "blackheads" and comedones on the face. Medical authorities claim that the mites do not cause "blackheads," and that they occur in healthy as well as diseased follicles. The mites migrate over the skin to enter new glands. They occur on children as well as adults, and in all parts of the world.

D. phylloides Csokor has been found in Canadian swine, causing white tubercles on the skin, from the size of a pin-head to that of a pea. Within each of these abscesses a number of the *Demodex* were crowded together. They did not appear to affect the health of the animal. *D. bovis* Stiles was recorded from hides of cattle in the United States. They formed swellings, about the size of a pea, on the skin. Within each there were a great number of mites. The presence of these tubercles lessens the value of the hide to a considerable degree. Herds could doubtless be cleaned by dipping in some liquid similar to the sheep and cattle dips now in use against other mites.

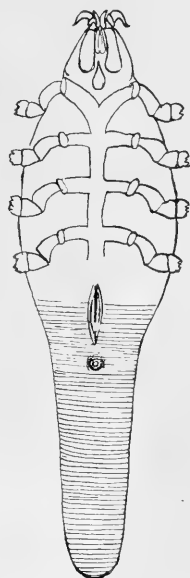


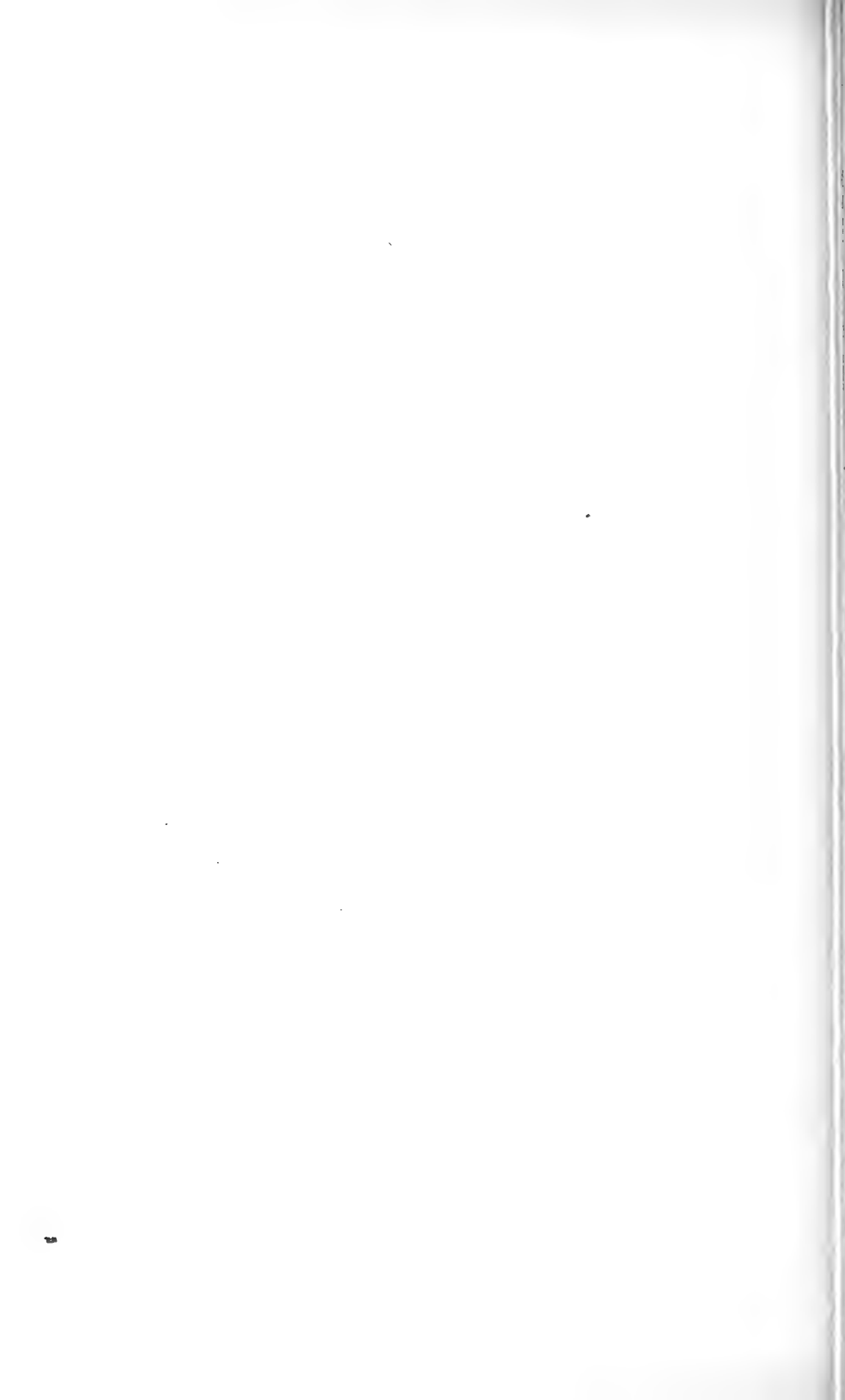
FIG. 201.—*DEMODEX*
FOLLICULORUM.

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NOTES ON HAWAIIAN REPTILES FROM THE ISLAND OF MAUI.

By RICHARD C. MCGREGOR,

Of the Philippine Museum, Manila, Philippine Islands.

As there has been no report on the lizards of Maui, the following notes on specimens, collected by the author during the winter of 1899-1900, may be of interest. The names are taken from the paper on Hawaiian Land Reptiles,^a by Dr. Leonhard Stejneger, who has kindly verified my identifications. All measurements are in inches and hundredths.

The specimens are in the U. S. National Museum.

HEMIDACTYLUS GARNOTII Duméril and Bibron.

Hemidactylus garnotii STEJNEGER, Proc. U. S. Nat. Mus., XXI, 1899, p. 792.

One specimen (Cat. No. 31268 U.S.N.M.) was taken at Maalaea Landing, March 8, 1900. Colors in life: Back marked with brown, black, and white; the white in regular rows of spots from snout to near end of tail; underside of body light lemon yellow, becoming very pale, almost white on throat and chin; underside of tail salmon, darker distally.

Another specimen (Cat. No. 31267 U.S.N.M.) was taken in February from beneath loose stones on summit of a hill near Lahaina. The eggs were first found at about 1,000 feet elevation in Iao Valley, where eight were taken from beneath small stones. They are nearly spherical in shape, being thus easily distinguished from those of the skink. The pure white shell is firm and brittle and of fine texture. Six examples measure as follows:

.40 by .36	.43 by .38	.40 by .36 inches
.41 by .37	.45 by .40	.40 by .34 inches

Of seven incubated eggs taken December 27, one was found hatched on January 13, about one-third of the shell having been broken away

^a Proc. U. S. Nat. Mus., XXI, 1899, p. 783.

at one end. Color of young in life: Above, sprinkled with yellowish black and brown points, and regularly marked with white dots; on the head and body the white dots are grouped at regular intervals, forming longitudinal rows—one row in middle of back, one row on each side of that, and one on each side of body; on snout these rows become less regular. On the tail the three dorsal rows are united, forming bars, which are still evident in the preserved specimen. The lateral spots are continued on sides of tail, occurring about twice as often as the bars. Spots on the legs are yellowish and produce an irregular pattern. Below, very pale greenish yellow, colored by internal organs; a red median streak in thoracic region; darker and brownish over the intestines; underside of tail salmon pink, darker toward the tip.

A young one just hatched measures as follows:

	Inches.
Total length.....	2.14
Vent to tip of tail.....	1.10
Snout to ear.....	.30
Fore limb.....	.34
Hind limb.....	.45

The young gecko is exceedingly active and able to spring for some distance. One which I put in a water glass clung to the side, either head or tail up, and even moved backward up the side of the glass. I noticed that the long, slender tongue was often thrust out and around to angle of the mouth, the tip extending over the eye, no doubt to moisten the eyeball.

PEROPUS MUTILATUS (Wiegmann).

Peropus mutilatus STEJNEGER, Proc. U. S. Nat. Mus., XXI, 1899, p. 796.

One specimen (Cat. No. 31270 U.S.N.M.) was taken near Lahaina under stones; same locality as the specimen of *Hemidactylus*. December 27 a small specimen was taken in Iao Valley at about 1,000 feet elevation (Cat. No. 31270 U.S.N.M.).

EMOIA CYANURA (Lesson).

Emoia cyanura STEJNEGER, Proc. U. S. Nat. Mus., XXI, p. 807.

This lizard is confined to the woods of the higher hills, my specimens being taken at about 1,000 feet elevation in Iao Valley. Two specimens had their mouths packed with small insects and larvæ. One has a curious malformation of the tail; a minute sprout growing from one side midway between vent and tip of tail. There is little variation among the head shields of my twelve specimens. In one (Cat. No. 31257 U.S.N.M.) the frontal and prefrontals are united to form a single shield. In another (Cat. No. 31256 U.S.N.M.) the frontal and right prefrontal are united with but an indication of the suture.

ABLEPHARUS BONTONII PÆCILOPLEURUS (Wiegmann).

Ablepharus bontonii pæcilopleurus STEJNEGER, Proc. U. S. Nat. Mus., XXI, 1899, p. 811.

This skink was abundant near Kahului in a pit cattle guard of the Maui railroad and among the sand hills a little back from the beach. It is confined to the lowlands, never being seen near the other species here listed. In the sand hills I found it an easy matter to capture plenty of specimens. Among the rocks it was useless to bother with them. Among my specimens there is considerable variation in the head shields, and these are given in tabular form.

Normal. I have designated as normal those specimens in which the prefrontals meet in a suture between the frontal and front nasal. This is the commonest condition, although the suture may vary in length.

Variation 1. The four above-mentioned shields meet at their corners, the sutures forming a flattened X.

Variation 2. A small, triangular shield in front of frontal, the apex pointing forward.

Variation 3. A small truncated triangular shield in front of frontal, the smaller end pointing backward.

Variation 4. Among the adults there is one specimen which is normal as to the shields under consideration, but some of the small post ocular shields of the left side are united, forming a long shield which overlaps the frontoparietal to its middle and covers part of the left parietal. This specimen is listed under normal and variation 4. Among the young are two with variation 3 and the frontonasal divided bisymmetrically. These are listed under variations 3 and 4.

The following table gives the variations among 32 adults and 24 young recently from the egg.

Age.	Normal.	Variations.			
		1.	2.	3.	4.
Adults.....	22	3	6	1	1
Young.....	12	1	7	4	2
Total.....	32	4	13	5	3

While collecting specimens of this lizard in the cattle guard mentioned above, large quantities of its eggs were found deposited in damp earth. In some instances they were stuck together in bunches of four or five. One "set" consisted of over seventy eggs in all stages of incubation. From some the young escaped as I held the eggs in my hand. Dozens of empty shells were found among the good eggs. The shell is dull, dirty white, soft and leathery. In shape the eggs resemble those of hummingbirds, but may be much rounder, and others are noticeably pointed at one or both ends. One example is

lopsided, measuring 0.55 by 0.33 by 0.30. The following measurements, selected from over fifty taken in the field, show some of the variations:

0.71 by 0.37	0.57 by 0.34 inches.
.70 by .33	.56 by .37 inches.
.69 by .24	.55 by .39 inches.
.68 by .35	.49 by .30 inches.
.60 by .38	.47 by .32 inches.

It may be seen that the length varies from 0.47 to 0.71 inch, and the short diameter from 0.24 to 0.39 inch.

While fresh the eggs are pink as any dove's egg, and, as might be expected, they become dark as the embryos develop. In the older eggs there is a reduction of the difference between the two diameters, the shell is more tense and the calcareous (?) matter is distributed in stellate spots.

The young escapes through a longitudinal slit a quarter of an inch long near one end of the egg, or the slit may be across one end. Occasionally there are two convergent slits, which meet near the end of the egg, forming a flap. The embryo lies in the shell with the body and tail coiled in snail fashion, the yolk being at the head end. Within 10 to 20 seconds after the envelope cracks the young lizard is out and away, being able to take care of himself at once. The following measurements are of a just-hatched young:

	Inches.
Total length	1.80
Vent to tip of tail.....	1.00
Snout to ear.....	.24
Fore limb.....	.30
Hind limb.....	.36

A few fresh eggs taken December 19 and kept on shipboard, resting on damp earth, hatched January 30. The head shields of the embryos show the same variations as the adults.

LABRACINUS THE PROPER NAME FOR THE FISH GENUS CICHLOPS.

By THEODORE GILL,

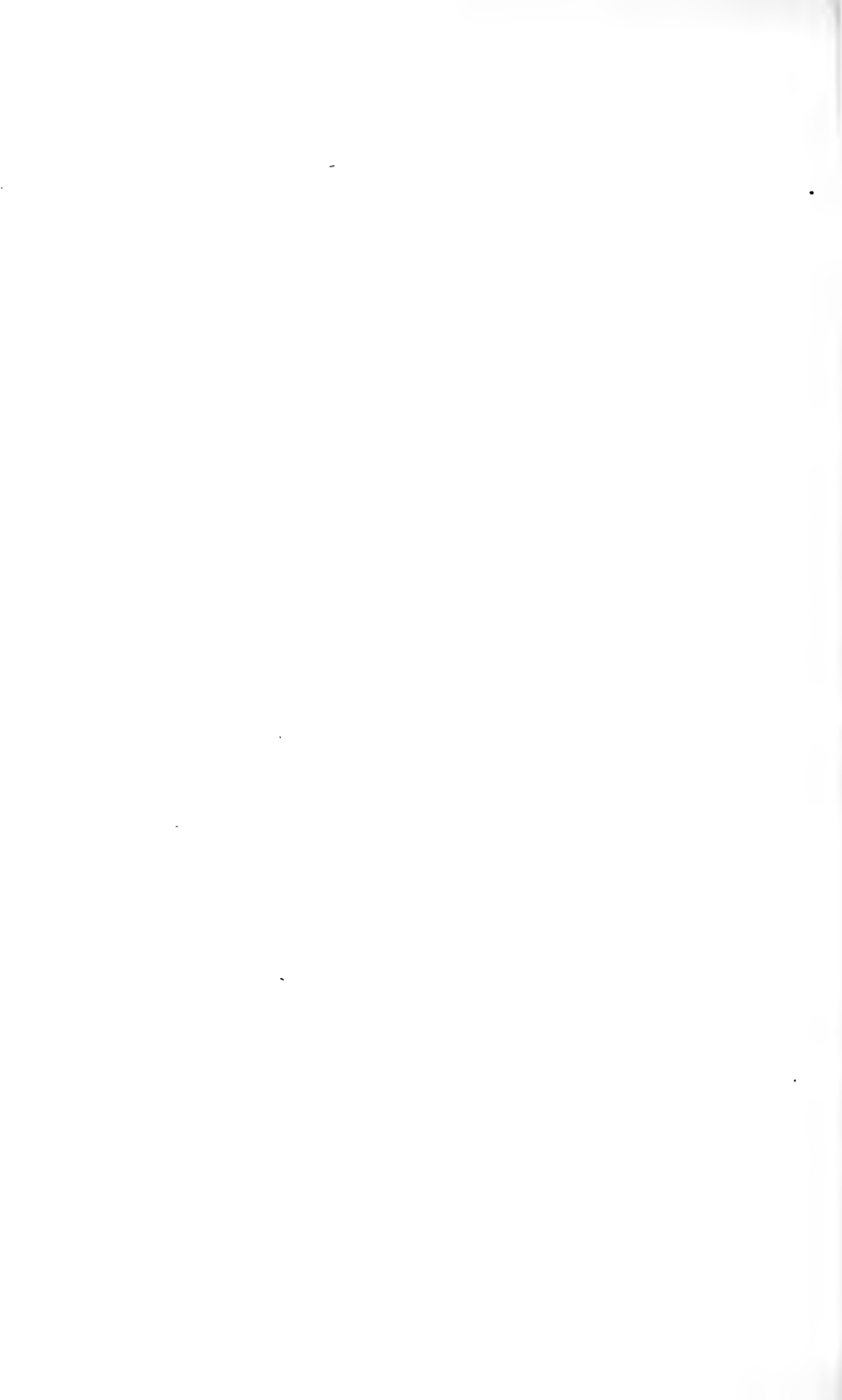
Honorary Associate in Zoology.

In 1849 Müller and Troschel, in the *Horæ Ichthyologicæ* (III, p. 24), gave the name *Cichlops* to a well-known genus of the family called by them *Pseudochromides* or, as now named, *Pseudochromidæ*. The name has been universally retained for the genus ever since, and last by Jordan and Snyder (1902) in a Review of the Trachinoid fishes and their supposed Allies found in the Waters of Japan.^a The identical name *Cichlops*, however, had been used several years previously (in 1844) for a genus of birds by Hodgson and published in Gray's *Zoological Miscellany* (p. 83). The avian genus is now regarded as a synonym of *Anthus*, but the early use of the name precludes its retention for the fish genus. For that genus *Labracinus* may be used; it was apparently originally given by H. Schlegel, without description or reference to a type, and simply to specimens in the Leyden Museum. At least this is the legitimate inference from the only known notice of the name, which occurs in the memoir of Bleeker. Bleeker, at the head of the genus *Cichlops*, has the reference "*Cichlops* M. Tr. = *Labracinus* Schl. (Mus. L. B.)."^b

As the facts thus indicated have not been noticed in late works, a new name might be given and the synonymy thus unnecessarily added to; to avoid this the present note is given.

^aProc. U. S. Nat. Mus., XXIV, 1902, p. 491.

^bThe first publication of the name *Labracinus* appears to have been made in Van der Hoeven's "*Handboek der Dierkunde*." After a diagnosis of "*Glaucosoma* Schl." a note is appended, viz: "ANNOT. Hic etiam collocandum videtur genus novum e mare indico prope Celebes, *Labracinus* Mus. L. B., cujus descriptionem a Doctissimo Schlegel exspectandum puto." This is translated in the English edition (II, p. 177): "NOTE.—Here also would seem to be the place for a new genus from the Indian Sea near Celebes, *Labracinus* Mus. L. B., of which I think the description may be expected from Doctor Schlegel." The expectation was never realized, and no one could have imagined what genus was intended, as *Labracinus* has no resemblance or affinity to *Glaucosoma*.



NOTE ON THE GENUS PRIONURUS OR ACANTHOCAULOS.

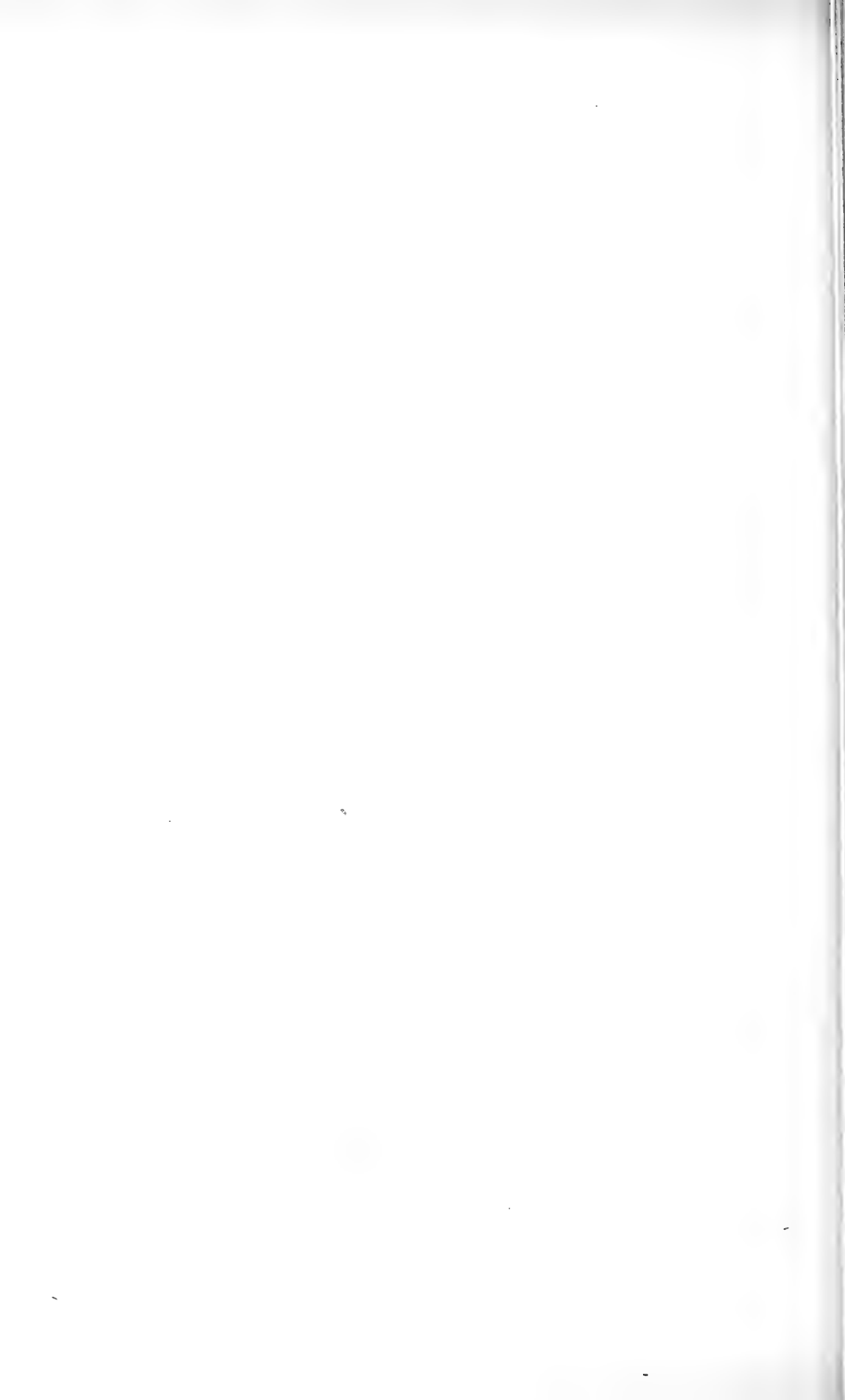
By THEODORE GILL,
Honorary Associate in Zoology.

In the Records of the Australian Museum for June, 1900 (III, p. 206), Mr. Edgar R. Waite has substituted "*Acanthocaulos*, *gen. nom. nov.*" for the familiar name *Prionurus* of Lacépède. "The name is suggested to replace *Prionurus*, Lacépède, 1830, preoccupied by Ehrenberg, in *Arachnida*, 1829." The data are erroneous.

The name *Prionurus* was first given by Lacépède in the *Annales du Muséum National d'histoire naturelle*, IV, p. 208, as indicated in the Synopsis of the genera of the superfamily Teuthidoidea.^a The article was presented to the museum in 1803 (an. XI) and published in 1804 (an. XII). An extended description was given under the name *Prionure microlepidote* (pp. 205, 206), and a diagnosis under the latin name *Prionurus microlepidotus* (p. 211). The case is thus perfectly clear.

It is probable that Mr. Waite overlooked the information given by his predecessors and was misled by Scudder's *Nomenclator Zoologicus*. Therein the only references to *Prionurus* are the following: *Prionurus* Ehr. *Arachn.* 1829. A. and *Prionurus* Less. *Pisc.* 1830. A. The reference is to Lesson 1830 and not Lacépède 1830. The letter "A" indicates Agassiz's *Nomenclator Zoologicus*.

^aProc. U. S. Nat. Mus., VII, 1884, p. 277.



DESCRIPTION OF A NEW SPECIES OF FISH (APOGON
EVERMANNI) FROM THE HAWAIIAN ISLANDS, WITH
NOTES ON OTHER SPECIES.

By DAVID STARR JORDAN AND JOHN OTTERBEIN SNYDER,
Of Stanford University.

A small collection of fishes from the market of Honolulu, lately received by the United States Bureau of Fisheries from Mr. E. L. Berndt, contains several specimens of interest, one species being new to science. The present paper contains the description of this species, with notes on some of the others.

APOGON EVERMANNI Jordan and Snyder, new species.

Head exclusive of opercular flap, $2\frac{2}{3}$ in the length; depth, $3\frac{1}{5}$; depth of caudal peduncle, $2\frac{2}{3}$ in head; eye, $3\frac{1}{2}$; snout, $3\frac{1}{2}$; maxillary, $1\frac{1}{4}$; interorbital space, $6\frac{1}{4}$; D. VI-I, 9; A. II, 8; pores in lateral line, 25.

The head is conspicuously large, snout pointed, mouth large, the maxillary extending to a point midway between pupil and posterior margin of orbit. The interorbital space is concave, viewed either from the side or from before, its width equal to that of the posterior edge of maxillary. Edge of suborbital and lower edge of preopercle with large, thin, membranous flaps; anterior edge of preopercle smooth; upper part of posterior edge finely serrated. Branchiostegals, 7. Teeth villiform, in broad bands on the jaws, a V-shaped patch on the vomer, and in narrow bands on the palatines. Gillrakers, 5+16, the length of the longest contained 3 times in longitudinal diameter of eye. Pseudobranchiæ present.

Head naked, except on interopercle, preopercle, and upper part of opercle, where there are a few large smooth scales. Scales of body ctenoid, the number in a longitudinal series immediately above the lateral line 54, between lateral line and spinous dorsal 3, between lateral line and anal 15. Lateral line complete, its curve closely following that of the dorsal contour of body; located on middle of caudal peduncle posteriorly.

Third and fourth dorsal spines longest, $2\frac{2}{3}$ in head; first and sixth of equal length, half as long as the third. A slight space between

dorsals, the spines when depressed just reaching base of second dorsal; spine of second dorsal measuring $3\frac{1}{6}$ in head, longest ray $1\frac{1}{2}$; distance between soft dorsal and base of caudal equal to width of space between anterior margin of eye and posterior edge of opercle. First anal spine minute, the second $3\frac{1}{2}$ in length of head; longest ray 2. Ventral reaching a point midway between anal opening and base of anal fin. Pectoral fin rather pointed, its tip reaching a vertical through middle of anal. Caudal forked.

In alcohol the color is very light (in life probably red), the body with five rather indistinct dark bands, none of which reach the ventral surface; the first on nape, second triangular in shape extending from base of spinous dorsal to near middle of body, third passing from base of second dorsal to a point near base of anal, the fourth located just behind the second dorsal, fifth at base of caudal; a narrow, dusky band passing from tip of snout to eye; a similar band from posterior margin of eye to edge of opercle.

A single specimen measuring about 142 mm., from the market at Honolulu. The condition of the tissues indicates that the example came from deep water. Type No. 51487, U. S. National Museum; collector, E. L. Berndt.

The species is named for Dr. Barton Warren Evermann, of the United States Bureau of Fisheries.

The following measurements of the type are expressed in hundredths of the length to base of caudal fin: Head, exclusive of opercular flap, 0.38; depth, 0.32; depth of caudal peduncle, 0.145; snout, 0.12; eye, 0.12; interorbital space, 0.06; length of maxillary, 0.21; tip of snout to spinous dorsal, 0.42; tip of snout to soft dorsal, 0.62; tip of snout to anal, 0.66; length first dorsal spine, 0.09; second, 0.13; sixth, 0.08; seventh, 0.12; length of first anal spine, 0.02; second, 0.11; length of pectoral, 0.28; length of ventral, 0.22.

CHANOS CHANOS (Forskål.)

A singular-looking fish, extraordinarily short and deep. It is apparently an abnormal dwarf or hunchback specimen of this species. It has a much shorter and deeper head and body than is usual and the scales are narrower, but in other respects it differs only slightly from the ordinary type. The head is contained $3\frac{2}{3}$ times in the length to the base of caudal; depth, $2\frac{1}{2}$; depth of caudal peduncle, $7\frac{1}{2}$; length of caudal, $1\frac{1}{3}$; pectoral, 4; ventral, 5; eye, 3 in head; interorbital space, $2\frac{1}{3}$; snout, $3\frac{1}{2}$; number of dorsal rays, 12; anal, 9; scales in lateral line, 76; in series between ventral and dorsal, 26; between occiput and base of dorsal, 21. A normal example measures as follows: Head, 4 in length; depth, 4; depth of caudal peduncle, 11; length of caudal, 3; pectoral, $6\frac{1}{4}$; ventral, $7\frac{2}{3}$; eye, 4 in head; interorbital space, $3\frac{1}{4}$; snout, $3\frac{3}{4}$; number of dorsal rays, 12; anal, 9; scales, 80-26-38.

SYNODUS VARIUS (Lacépède).

An example remarkable for its size, 350 mm. long; differs in no way from smaller specimens.

SARDA CHILENSIS (Cuvier and Valenciennes).

A specimen about 600 mm. long, belongs without doubt to this species. The head is contained $3\frac{1}{2}$ times in the length; the maxillary extends to a vertical through posterior edge of orbit. There are six dark oblique stripes on the body, the uppermost and lower ones being indistinct. Dorsal with eighteen spines. This is the first record of the species from Hawaii. Apparently the identification of the Japanese *Sarda orientalis* and the California *Sarda lineolata* with *Sarda chilensis* from Chile is fully justified.

NOVACULICHTHYS KALLOSOMA (Bleeker).

One specimen, the second recorded from the Hawaiian Islands. Ground color, grass green, as in an example from Samoa.

CALLICANTHUS METOPOSOPHRON Jenkins.

One specimen, 284 mm. long. Head, $4\frac{1}{3}$ in length; depth, $2\frac{3}{5}$; eye, $3\frac{1}{8}$ in head; snout, $1\frac{1}{8}$.

OSTRACION SEBÆ Bleeker.

Ostracion camurum JENKINS, Bull. U. S. Fish Com. for 1899, p. 396, fig. 9, Honolulu.

Five specimens, measuring from 85 to 120 mm. in length; differ in no way from specimens collected by Dr. Jordan in Samoa. Two examples have the ventral surface without spots, while two others have the same area spotted like the back. In one specimen the spots extend inward along the edges of the ventral surface of the carapace. Some have the caudal peduncle with spots only, while others have elongate white bands of irregular shape, no two being alike in this regard. The largest individual has a transverse white band between the eyes.

TROPIDICHTHYS PSEGMA Jordan and Evermann.

One specimen, measuring 118 mm. The dorsal has 12 rays; the snout measures $1\frac{2}{5}$ in head; the dorsal prominence is equally distant between tip of snout and base of last dorsal ray. This is the second specimen recorded, but several others were taken in Samoa by Jordan and Kellogg in 1901.

CHEILODACTYLUS VITTATUS Garrett.

Two specimens, measuring 175 and 245 mm. long, respectively; larger and more deeply colored than any of the few specimens hitherto known.

IRACUNDUS SIGNIFER Jordan and Evermann.

One specimen, 100 mm. long; agrees perfectly with the original description of the species, this being the second specimen known.

DENDROCHIRUS CHLOREUS Jenkins.

One specimen. Dorsal rays, 10; anal, 6; the last ray double in each case.

DENDROCHIRUS BARBERI (Steindacher).

Dendrochirus hudsoni Jordan and Evermann is without doubt identical with *Pterois barberi* Steindachner. An examination of two of the cotypes of the former shows that they differ from the latter species, as described and figured by Steindachner, only in the length of the pectoral, the difference however not being greater than the diameter of the pupil.

CEPHALACANTHUS ORIENTALIS (Cuvier and Valenciennes).

Renewed examination of the common flying gurnard of Hawaii convinces us that this species is the original *orientalis*. The same species occurs in Japan, as also a second species, *Cephalacanthus peterseni* (Nystrom), in which the second free spine of the dorsal is lacking.

ANTENNARIUS COMMERSONI Lacépède.

Two specimens, typical in character.

DESCRIPTIONS OF NEW GENERA AND SPECIES OF HYMENOPTERA FROM THE PHILIPPINE ISLANDS.

By WILLIAM H. ASHMEAD,
Assistant Curator, Division of Insects.

In a paper^a entitled A List of the Hymenoptera of the Philippine Islands, with descriptions of New Species, I recorded 183 species of these insects from the Philippines, although several doubtful species mentioned by Fr. Castro de Elera in his *Catalogo de toda la Fauna Filipinäs* were cited but not included in this number. Two genera and thirty-one species were described as new to science in this first paper.

Since the list appeared, however, I have found references to five species overlooked by me. These are: (1) *Ampulex lævigata* Kohl, (2) *Pompilus graphicus* Smith, (3) *Chalcis æræne* Walker, (4) *Pimpla* (*Euxorides*?) *furcifer* Bingham, and (5) *Stephanus indicus* Westwood. Mr. P. Cameron, the eminent English hymenopterist, has also kindly called my attention to two species described by Gribodo,^b viz., *Sphex sulciscuta* and *Hemipepsis tagala*, from the island of Mindoro. Father W. A. Stanton continues to send me the Hymenoptera collected by him in the Observatory Garden at Manila, and I am now able, with the new material received from him and from Father Robert Brown, to contribute further toward advancing the knowledge of the hymenopterous fauna of the archipelago. Below I describe four new genera and forty-five new species of Hymenoptera, many of the latter in genera and families not before known to have representatives in the Philippines.

The new genus *Stantonia*, named in honor of Father Stanton, is of special interest, as it is a true Agathine, but departs somewhat in the characters of the venation from all other known genera in the group.

The paper terminates with a check list, systematically arranged, of the Hymenoptera now known to occur in the Philippine Islands.

^a Jour. New York Ent. Soc., March, 1904, pp. 1-22.

^b *Miscellanea Entomologica*, II, 1894, p. 2.

Undoubtedly, however, hundreds still remain unknown to us, and if these insects were systematically collected in the islands the list could be greatly increased by many of the described species known in India, Ceylon, Java, Borneo, and other islands of the Malayan region.

The author would be glad to receive and determine Hymenoptera from any part of the Philippines.

Family IX. MEGACHILIDÆ.

Subfamily II. MEGACHILINÆ.

Genus MEGACHILE Latreille.

MEGACHILE ROBBII, new species.

Female.—Length, 10 mm. Black, the head above (the only portion to be seen on account of the dense pubescence) closely punctured, the thorax sparsely punctured, the abdomen smooth; the first, second, and third dorsal segments are sparsely microscopically punctate toward base, smooth toward apex; the front of the head and the clypeus, the sides of the thorax, the mesothorax laterally, the metathorax, and the basal segment of the abdomen are clothed with rather a dense fulvous pubescence; the legs with a griseous pubescence, the scopa of the tarsi ferruginous, the apical margin of the second abdominal segment and the third, fourth, and fifth laterally with a dirty whitish or griseous pubescence; the ventral scopa is long and dense, and tinged with yellow. Wings subfuscous; the stigma and veins black. Antennæ wholly black.

Type.—Cat. No. 8028, U.S.N.M.

Manila. Described from a single specimen captured by Mr. M. L. Robb.

Family XII. ANDRENIDÆ.

Subfamily II. HALICTINÆ.

Genus HALICTUS Latreille.

HALICTUS PHILIPPINENSIS, new species.

Female.—Length, 5.5 mm. Aeneous black, the thorax above dull bronzed, minutely punctate, clothed with a whitish pubescence, which is rather dense on the face, pronotum above, post-scutellum and the plura; the clypeus is somewhat produced anteriorly, trapezoidal, and sparsely punctate; the face below the ocelli is closely, minutely, opaquely punctate; the vertex is almost smooth and shining; the antennæ are black, the flagellum at apex beneath brownish; the funicle joints, after the first, wider than long, the first joint obconical, hardly longer than thick; the wings are hyaline, with the tegulæ, the stigma, and the veins, except the subcostal vein, testaceous; the subcostal vein

is black; the second cubital cell is small, a little wider (higher) than long and receives the first recurrent nervure very near its apex; the third cubital cell is larger and receives the second recurrent nervure at its apical third. Legs black, the scopa whitish, the hind tarsi with joints 2-4 at apex, the last joint and the claws testaceous. The abdomen is oblong-oval, smooth, and shining, with the dorsal segments 2 and beyond microscopically shagreened, the terminal segment fringed with short, stiff, black hairs; otherwise the abdomen is clothed with a whitish pubescence, the first and second dorsal segments with tufts laterally.

Type.—Cat. No. 7994, U.S.N.M.

Manila. Described from a single specimen taken by Father Stanton.

Family XVI. CRABRONIDÆ.

Subfamily V. RHOPALINÆ.

Genus DASYPROCTUS Lepeletier and Brullé.

DASYPROCTUS PHILIPPINENSIS, new species.

Female.—Length 8 mm. Black, subopaque, finely, closely punctured, the clypeus and lower part of the cheeks clothed with a silvery white pubescence; scape, pedicel, mandibles, except the teeth, the upper margin of the pronotum, the prothoracic tubercles, the scutellum, two small spots at the apex of the abdominal petiole, a large transverse mark on each side of the second dorsal segment, a small spot on each side of the third segment, a stripe at the base of the fourth segment, interrupted at the middle, and the fifth segment, except narrowly at apex, and the legs, except the coxæ, trochanters, the hind femora entirely, the basal two-thirds of the front and middle femora *above*, and a spot on the hind tibiæ beneath toward apex, which are black, are yellow; the two or three apical joints of the hind tarsi are more or less fuscous. Wings hyaline, the stigma and veins blackish.

Male.—Length 6 mm. Agrees well with the female, only the pedicel is black, not yellow; the yellow margin on the pronotum is interrupted at the middle, the scutellum wholly black, the abdomen black, except a yellow spot on each side of the second dorsal segment, a minute yellow spot on each side of the fourth, and a yellow stripe on each side at apex of the fifth, while the legs are mostly black, with the apices of the front and middle femora, their tibiæ outwardly, and their tarsi, except the two or three terminal joints of the middle tarsi, yellow; the three terminal joints of the middle tarsi and the hind tarsi, except at base, are usually fuscous.

Type.—Cat. No. 7909, U.S.N.M.

Manila. Described from specimens found by Father Stanton, forming cells in the pithy stems of various plants.

Genus RHOPALUM Kirby.

RHOPALUM ALBOCOLLARE, new species.

Female.—Length 4.5 mm. Black and shining, impunctate, the pronotum above, the scutellum, the apex of the postscutellum, the middle tarsi, and a broad annulus at base of the hind tarsi, snow-white; scape honey-yellow; flagellum filiform, black; eyes large, strongly convergent anteriorly; metathorax smooth, with a median grooved line which is strongly impressed on the truncature. Wings hyaline, the stigma and veins blackish, the recurrent nervure received by the first cubital cell a little before its middle. Abdomen clavate, longly petiolated, the petiole highly polished and shining; clavate fully two-thirds as long as the body of the abdomen.

Type.—Cat. No. 7995, U.S.N.M.

Manila. Described from a single specimen taken by Father Stanton in the Observatory Garden, at Manila.

Family XIX. LARRIDÆ.

Subfamily I. LARRINÆ.

Genus NOTOGONIA Costa.

NOTOGONIA MANILÆ, new species.

Female.—Length 6.5 mm. Entirely black, pruinose, the pubescence on the face, clypeus, and temples denser and silvery-white, that on the pygidium tinged with ferruginous; head and thorax finely minutely punctured, the scutellum smoother, polished, the metathorax finely rugulose, subopaque, the abdomen polished, shining, the pubescence a little denser and more distinctly silvery at apex of first, second, and third dorsal segments, especially laterally. Wings hyaline, the front wings faintly fuscous at the apical margins, the stigma and veins brown-black. Antennæ 12-jointed; the flagellum is filiform, the joints subequal in length, the first being nearly twice as long as the pedicel. The tarsi are spinous and much longer than their tibiæ; the joints 3 and 4 of front and middle tarsi are short and united scarcely longer than the fifth or last joint; the fourth joint of the hind tarsi is much shorter than the third, the last joint being about as long as the third.

Male.—Length 5 to 5.5 mm. Hardly distinguishable from the female except in being smaller and by the structure of the antennæ and abdomen. The antennæ are 13-jointed, the first joint of the flagellum being nearly thrice as long as the pedicel, which is shorter than in the female, while the terminal abdominal segment is without a pygidial area.

Type.—Cat. No. 7996, U.S.N.M.

Manila. (Father W. A. Stanton.)

Subfamily IV. PISONINÆ.

Genus PISON Spinola.

PISON LAGUNÆ, new species.

Male.—Length 7 mm. Black, clothed with a sparse silvery-white pubescence, rather dense on the clypeus, the head and thorax somewhat closely punctured, the scutellum shining and sparsely punctate, the metathorax truncate behind, its posterior face with a median sulcus, transversely rugulose, the upper surface with a slight median depression posteriorly, the depression with about four transverse raised lines beyond a short median raised line that extends from the base of the postscutellum, the surface on either side to this line with oblique raised lines; tarsi brownish piceous, somewhat reddish beneath. Wings hyaline, the stigma and veins black, the areolet triangular, petiolate; the first recurrent vein is interstitial with the first transverse cubitus; tegulae testaceous posteriorly, blackish anteriorly. Abdomen smooth and shining, the first and second segment sparsely and minutely punctate.

Type.—Cat. No. 7939, U.S.N.M.

Bay Laguna. (Dr. P. A. Stangl.)

Genus PISONITUS Shuckard.

PISONITUS ARGENTEUS, new species.

Female.—Length 5.5 mm. Black and shining, the temples posteriorly, the cheeks, face, mesopleura, and metathorax, except medially, clothed with a dense silvery-white pubescence; the head and thorax are subopaque, coriaceous, not distinctly punctate, the metathorax somewhat rounded, not distinctly truncate posteriorly, but with a short median sulcus; the upper face has a distinct long median carina that extends from the postscutellum to near the beginning of the median sulcus, the upper surface without oblique raised lines, but laterally it is clothed with a silvery pubescence; legs black, the front tibiae and tarsi beneath testaceous. Wings hyaline, the stigma and veins piceous black, the areolet triangular, petiolate, receiving the second recurrent nervure slightly beyond its middle; the first recurrent nervure joins the median vein before the first transverse cubitus. Abdomen smooth and shining, but the first segment is microscopically punctate, the depression at apex being clothed with a silvery pubescence; the second and third segments at apex, and especially laterally, are also more or less clothed with a silvery pubescence.

Type.—Cat. No. 7940, U.S.N.M.

Bacoor. (Dr. P. L. Stangl.)

Family XXII. MELLINIDÆ.

Genus MEGALOMMA Smith.

MEGALOMMA QUADRICINCTUM, new species.

Female.—Length, 7 mmr. Black; face, clypeus, a line on inner orbits opposite the insertion of the antennæ, a spot at base of mandibles, the palpi, scape, pedicel, the first joint of the flagellum beneath, the two terminal joints of antennæ beneath, a line on the pronotum above and enclosing the tubercles, or the hind angles of the pronotum, the tegulæ, a spot on each side of the mesonotum next the tegulæ, the postscutellum, the apices of femora, all tibiæ, except the hind tibiæ beneath and the last joint of the hind tarsi, two spots on first segment of abdomen at apex, and bands at apex of dorsal segments 2, 3, 4, and 5, yellow. Wings hyaline, the stigma and veins black.

The flagellum is strongly clavate; the eyes are very large, strongly faceted, and converge anteriorly; there is no malar space; the thorax above is rather coarsely punctured, the metathorax less strongly punctured, with a smooth median space at base above, the posterior face with some silvery pile.

Type.—Cat. No. 7997, U.S.N.M.

Manila. (Father Stanton.)

Family XXVII. CEROPALIDÆ.

Subfamily I. PEPSINÆ.

PSEUDOSALIUS, new genus.

This genus is proposed for a ceropalid found in the Philippines, in our catalogues under the name *Salius bipartitus* Lepeletier. A study of a specimen shows that it is not a *Salius*, but comes much closer to the genera *Culicurgus* and *Ferreolomorpha*, but is easily separated by having the submedian cell in the front wings distinctly shorter than the median. The claws, too, are also different from those in *Salius*; in the female they are cleft. The metanotum is transversely wrinkled or striated, the labrum subexserted, the mandibles bidentate, the maxillary palpi 6-jointed, the third joint, the longest, as long as the first and second united, while the labial palpi are 4-jointed, the second joint being the longest.

Genus PALLOSOMA Lepeletier.

To this genus belongs *Salius fulgidipennis* Saussure, which is reported from the Philippines. It agrees perfectly with the structural characters given for this genus, although the wings are not margined with black at apex, as in other species.

Subfamily II. AGENIINÆ.

Genus AGENIA Schiödte.

AGENIA CINGULATA, new species.

Male.—Length, 6 mm. Black, clothed with a glittering pile, silvery on the face, the clypeus, the mesosternum posteriorly, and the hind coxæ; the tips of the front femora, their tibiæ and tarsi, the apical half of the middle femora, and the apical two-thirds of the hind femora rufous; the first segment of the abdomen has a yellowish-white band at the middle, while the pygidium is pure white. Wings hyaline, the tegulæ testaceous, the stigma and veins black.

Type.—Cat. No. 7998, U.S.N.M.

Manila. (W. A. Stanton.)

Family XXVIII. VESPIDÆ.

Subfamily II. POLISTINÆ.

POLISTELLA, new genus.

Plate I, Fig. 1.

This is a new generic term proposed for the smallest social wasp known in the world, named *Polistes manillensis* Saussure.

My generic table of the Vespidae^a may be modified to include it as follows:

3. Metathorax transversely striate or aciculate; abdomen long fusiform or elongate ovate, sessile; second cubital cell not small, along the cubitus as long as the third, receiving both recurrent nervures widely separated; eyes not extending to base of the mandibles *Polistes* Latreille

(Type, *Vespa biglumis* Linnæus.)

Metathorax smooth, not transversely striate; abdomen fusiform, subpetiolate; second cubital cell very small and narrow, along the cubitus hardly one-third the length of the third, receiving both recurrent nervures close together; eyes extending to base of mandibles *Polistella* Ashmead

(Type, *Polistes manillensis* Saussure.)

Family XXIX. EUMENIDÆ.

Subfamily IV. EUMENINÆ.

Tribe II. ODYNERINI.

Genus LEIONOTUS Saussure.

LEIONOTUS PUNCTUM Saussure. Manila.

Genus ANCISTROCERUS Westwood.

ANCISTROCERUS BIZONATUS Boisduval.

Odynerus bizonatus BOISDUVAL, Fn. entom. de l'Océan Pacif., p. 658.

^aCanadian Entomologist, June, 1902, p. 165.

Family XXXII. BETHYLIDÆ.

Subfamily I. BETHYLINÆ.

Genus DISSOMPHALUS Ashmead.

DISSOMPHALUS TIBIALIS, new species.

Female.—Length, 2.8 mm. Black, highly polished, impunctate. The scape and pedicel are yellow, the flagellum brownish yellow, the joints transverse, submoniliform. The mandibles, except at apex, are reddish. The tibiae and tarsi are yellowish white. The head is oblong, about $1\frac{1}{2}$ times as long as wide, without ocelli; the eyes oval, placed on each side anteriorly, while the abdomen is long, conically produced, more than twice as long as the thorax.

Type.—Cat. No. 7999, U.S.N.M.

Manila. (W. A. Stanton.)

Genus GONIOZUS Förster.

GONIOZUS PHILIPPINENSIS, new species.

Female.—Length, about 2 mm. Polished black, shining; the head and thorax faintly pubescent; the oblong head with some minute punctures. The antennae entirely, and the legs, except the front and hind coxae and their femora, which are blackish or brownish piceous, are brownish yellow. Wings hyaline; the parastigma and stigma dark brown; the veins pallid or hyaline. The branch from the basal vein is fully as long as the first abscissa of the basal vein, or possibly a little longer. All the flagellar joints after the first are moniliform.

Male.—Length, 1.6 mm. Agrees well with the female, except that the head is proportionately smaller, and the legs are wholly brownish yellow; the tibiae and tarsi a little paler, more yellowish white.

Type.—Cat. No. 7910, U.S.N.M.

Manila. Described from specimens bred by Father Stanton from a larva of a small Lepidopteron.

Subfamily III. DRYININÆ.

Genus DRYINUS Latreille.

DRYINUS STANTONI, new species.

Female.—Length, 3.5 mm. Black and shagreened, but clothed with a fine sericeous pile; scape except at base, the pedicel at apex, the clypeus except at apex, the legs except as hereafter noted, and the apex of the abdomen rufo-testaceous. The base of the pedicel, the bidentate apex of the clypeus, and the apex of front coxae and trochanters are whitish, while the middle and hind coxae and the extreme tips

of femora are more or less blackish or fuscous. Wings hyaline, but with a narrow fuscous band across the basal vein and a broad fuscous band across from the apical half of the stigma and enclosing the stigmal vein.

Type.—Cat. No. 8000, U.S.N.M.

Manila. (Father W. A. Stanton.)

Family XLII. MUTILLIDÆ.

Subfamily I. MUTILLINÆ.

Tribe II. MUTILLINI.

Genus MUTILLA Linnæus.

MUTILLA SEMPERI, new species.

Male.—Length, 6 mm. Black, except the first and second segments of the abdomen, which are red, clothed with glittering white hairs. The pubescence is denser on the face and clypeus, pronotum above, mesopleura anteriorly and narrowly at the base of the metanotum.

The head and thorax are distinctly punctured, the metathorax being coarsely reticulated. The abdomen is punctate, but the punctures are finer and less distinct on the apical three or four segments. Wings hyaline, but broadly margined with fuscous at apex; the veins dark or blackish.

Type.—Cat. No. 8001, U.S.N.M.

Manila. Dedicated to Mr. George Semper, the author of *Die Schmetterlinge der Philippinschen Inseln*, published during the years 1886 to 1892.

Family LV. CERAPHRONIDÆ.

Genus CERAPHRON Jurine.

CERAPHRON MANILÆ, new species.

Female.—Length, 1 to 1.2 mm. Black and shining, the head and thorax microscopically shagreened; the antennæ, except the last three joints, which are black, and the legs are brownish yellow. The last three joints of the flagellum are large and form a club, the first joint of which is only a little longer than thick, the last being fusiform and twice as long as the first, the funicle joints preceding the club, being small, transverse or submoniliform.

Type.—Cat. No. 7911, U.S.N.M.

Manila. Described from 10 specimens, 9 females and 1 male, received from Father Stanton. The single male has lost its head, but is easily recognized by its smaller size and the different shaped abdomen.

Family LXII. CHALCIDIDÆ.

Subfamily II. CHALCIDINÆ.

Tribe I. CHALCIDINI.

Genus CHALCIS Fabricius.

CHALCIS PRODENIÆ, new species.

Male.—Length, 1.5 mm. Black, with whitish colored eyes, the ocelli pale, the head and thorax closely and distinctly punctate, faintly pubescent; the abdomen highly polished, impunctate; the legs are black, but there is a small spot at base of the tibiæ, and all tarsi are yellowish white; the antennæ are black, but the flagellum is brownish at apex and is not quite thrice as long as the scape.

Type.—Cat. No. 7912, U.S.N.M.

Manila. Described from a single specimen bred by Father Stanton from the larva of a *Prodenia* sp. It is probably the smallest species in the genus.

Tribe III. CHALCITELLINI.

Genus ARRETOCERA Kirby.

ARRETOCERA STANTONI, new species.

Female.—Length, 2 mm. Black, the thorax distinctly punctate, the metathorax rugulose; the abdomen is longly petiolated, the petiole cylindrical, fully as long as the long hind coxæ, and furrowed above; the body of the abdomen is compressed, highly polished; seen from the side it is ovate, the first segment occupying most of its entire surface; the scape, pedicel, tegulæ, and most of the legs, except the tarsi, the hind coxæ, and femora, are flavo-testaceous, the flagellum light brown, the hind coxæ black, the hind femora reddish with an obscure dusky tinge outwardly, the tarsi white. Wings hyaline, the long, slender, marginal vein brown, the stigmal vein subsessile, the postmarginal vein not developed.

Male.—Length, 1.8 to 2.1 mm. Agrees well with the female, except that the flagellum is filiform, longer, yellowish, or with three or four terminal joints black; the petiole of the abdomen is longer and more slender than in the female, longer than the hind coxæ; the body of of the abdomen, as seen from the side, pear-shaped, testaceous at base, the hind femora more obscured, in one specimen almost black.

Type.—Cat. No. 7913, U.S.N.M.

Manila. (Father W. A. Stanton.)

Family LXVIII. ENCYRTIDÆ.

Tribe I. ECTROMINI.

TAFTIA, new genus.

Plate II, figs. 1 and 2.

It is interesting to detect a genus in this tribe in the Philippines, and that it should prove to be new, although closely allied to *Anagyrus* Howard, described from Ceylon. The two, however, may be separated as follows:

- Lateral ocelli close to the eye margin; scape in female usually broadly compressedly dilated beneath, the flagellum slender, cylindrical; axillæ not quite meeting at inner basal angles; front wings with a hairless line extending obliquely inward from the stigmal vein *Anagyrus* Howard.
- Lateral ocelli at least their width from the eye margin; scape in female long, subclavate, the flagellum clavate, the club much enlarged, the funicle joints a little longer than thick; in the male the flagellum is filiform; axillæ transversely wedge-shaped, meeting at inner basal angles; front wings without the hairless line extending obliquely inward from the stigmal vein; stigmal vein strongly curved, the marginal vein short..... *Taftia* Ashmead.
- (Type, *T. prodeniæ* Ashmead.)

This genus is named in honor of the first governor of the Philippines, Hon. William H. Taft, now Secretary of War in President Roosevelt's Cabinet.

TAFTIA PRODENIÆ, new species.

Female.—Length, 1.5 mm. Robust, metallic brown, shagreened; the head in front purplish; the eyes whitish, hairy; the ocelli pale; the scape and legs are flavo-testaceous; the flagellum is long clavate, brown-black, the pedicel nearly twice as long as thick, obconical; wings hyaline, the veins brown. The head is nearly twice as wide as thick antero-posteriorly, as wide as the thorax or a little wider, the eyes only slightly converging above; the pronotum is very short, transverse linear; the mesonotum is much wider than long, hardly as long as the convex scutellum; while the metanotum is very short. Abdomen broadly oval, sessile, not longer than the thorax, above depressed, beneath subcompressed, the hypopygium subprominent.

Male.—Length, 0.8 mm. Smaller and less robust, the head above and the thorax bronzed green, the head in front and beneath dark blue, the flagellum filiform, nearly of a uniform thickness throughout, the legs (except the hind legs, which are brownish piceous) are more yellowish, with all tarsi white or yellowish-white.

Type.—Cat. No. 7914, U.S.N.M.

Manila. Seventeen female and seven male specimens bred by Father Stanton from a *Prodenia* sp.

Family LXX. ELASMIDÆ.

Genus ELASMUS Westwood.

ELASMUS PHILIPPINENSIS, new species.

Female.—Length, 1 mm. Blue-black, the abdomen mostly red, with its pointed tip black, the postscutellum waxy-white, the scape pale yellowish, the flagellum brown-black, pubescent; legs yellowish white, the middle and hind femora dark or blue-black; the black hairs on the hind tibiæ are arranged to form nine or ten oval areas. Wings hyaline, the veins brown.

Type.—Cat. No. 7915, U.S.N.M.

Manila. Four female specimens (Father W. A. Stanton).

Family LXXI. EULOPHIDÆ.

Subfamily I. ENTEDONINÆ.

Tribe II. OMPHALINI.

Genus CLOSTERO CERUS Westwood.

CLOSTERO CERUS BROWNII, new species.

Female.—Length, 0.8 mm. Aeneous black, smooth and shining, the mesonotum metallic greenish and very delicately microscopically reticulated; the scape and pedicel are yellow, the rest of the antennæ being black; the legs, including the coxæ, are yellowish-white, while the abdomen is pointed ovate, sessile. Wings hyaline, the nervures light brownish.

Male.—Length, 0.65 mm. Agrees well with the female, except that it is smaller, the abdomen smaller and oval, the middle mesothoracic lobe with a median furrow posteriorly, while the flagellum is slender, the joints with some long, sparse black hairs.

Type.—Cat. No. 8041, U.S.N.M.

Manila. Described from specimens, representing both sexes, received from Father Robert Brown, and in honor of whom the species is named.

Tribe III. ENTEDONINI.

Genus ASECODES Förster.

ASECODES ELASMI, new species.

Male.—Length, 0.6 mm. Uniformly dark blue, except the tarsi, which are snowy white with the last joint dark brown or fuscous, the head on the vertex and the mesothorax and the scutellum with a metallic greenish tinge; joints of the flagellum loosely joined, moniliform; wings hyaline.

Type.—Cat. No. 7916, U.S.N.M.

Manila. Four specimens bred by Father Stanton, from *Elasmus philippinensis*.

Subfamily II. APHELININÆ.

Tribe I. APHELININI.

Genus ASPIDIOTIPHAGUS Howard.

ASPIDIOTIPHAGUS ALEYRODIS, new species.

Female.—Length 0.6 mm. Head and thorax above, brownish-yellow; the face, cheeks, thorax beneath and at sides, and the scape of the antennæ yellowish-white or milky-white; the eyes, the incision or suture on each side of the scutellum, the metanotum, and the abdomen are brown-black; the flagellum is pale brown, with some sparse dark-colored hairs, while the wings are clear hyaline, iridescent, with a long marginal fringe, the marginal vein being pale or yellowish, the stigmal vein not at all developed.

Male.—Length 0.4 to 0.5 mm. Paler colored than the female, the head, except the eyes, the thorax, scape of antennæ, legs, and the base of the abdomen being yellowish-white; rest of the abdomen and the eyes brown-black; the flagellum is slender, tapering at tip, and brownish; otherwise it is similar to the female, but with a much smaller and shorter abdomen.

Type.—Cat. No. 7324, U.S.N.M.

Manila. Described from 3 female and 2 male specimens bred by Father W. A. Stanton from an Aleyrodes affecting the sugar cane.

Family LXXIV. EVANIIDÆ.

Subfamily I. EVANIINÆ.

Genus EVANIA Fabricius.

EVANIA ANNULIPES, new species.

Male.—Length 4.5 mm. Black; the head and thorax coarsely rugosely punctate; face below the insertion of the antennæ and the cheeks anteriorly longitudinally striate; the cheeks posteriorly smooth and highly polished, but with a row of punctures along the eye margin; a spot at base of mandibles, the trochanters (except the hind trochanters), the tibial spurs, and a broad band at base of the hind tibiae are white or yellowish-white; the base of the front and middle tibiae and their tarsi are yellowish, their femora, except at apex, are fuscous or dark rufo-piceous; rest of the legs, except as noted, black. The antennæ, except the first five joints, which are honey-yellow, are black; the scape is long, as long as the pedicel, and joints 1 to 5 of the flagellum united; the flagellum is thickened toward the apex from the fourth joint, the first joint being the longest and slenderest—about as long as joints 2 and 3 united; the third joint is the shortest, being only a little longer than thick. The abdomen is very small, polished black, longly petiolated; the petiole yellow beneath at basal

half, with some punctures above. Wings hyaline, with a cloud across from the stigma, the veins blackish, the parastigma separated from the stigma by a white spot.

Type.—Cat. No. 8002, U.S.N.M.

Manila. (Father W. A. Stanton.)

Family LXXVI. ICHNEUMONIDÆ.

Subfamily II. CRYPTINÆ.

Tribe III. HEMITELINI.

Genus OTACUSTES Förster.

OTACUSTES ALBOANNULUS, new species.

Female.—Length 4 mm. Black, the apex of the abdomen with a white spot; eyes very large, occupying the whole side of the head and whitish in color; temples very flat; the head and thorax are finely punctured, the metathorax finely rugulose, the areas distinct, the two basal lateral areas almost smooth, shining, the apical transverse carina acute at the angles; the basal three joints of the antennæ and the legs are ferruginous, the hind coxæ, tips of hind femora and the hind tibiæ (except a narrow white annulus at base), are dark fuscous; the flagellum, except joints 4 to 6, is black; joints 4 to 6, and the palpi, are white. Wings fuscous, with the base and a band across from before the stigma, white or hyaline.

Type.—Cat. No. 8003, U.S.N.M.

Manila. (Father Stanton.)

Genus ASTOMASPIS Förster.

ASTOMASPIS METATHORACICA, new species.

Female.—Length 4.2 mm.; ovipositor only about half the length of petiole. Black; eyes large, dirty white; ocelli pale; the clypeus, mandibles, the hind angles of the prothorax, the scutellum, the metathorax, the mesopleura, and the first and second segments of the abdomen, are red; the other segments of the abdomen are black, but narrowly margined with white at apex; the scape of the antennæ beneath, the tegulæ, and the costal veins, are yellowish-white; the flagellum is blackish or dark brown above, ferruginous beneath, and very slender; legs red, the apex of the hind femora black, the hind tibiæ with a white annulus at base, outwardly and at the apex, and the hind tarsi, fuscous. Wings hyaline, with a fuscous cloud across from the stigma. The head above and the mesothorax are transversely rugulose, the metathorax completely areolated, rugulose. The abdomen has a

peculiar sculpture, the first three segments being more or less striato-rugulose and punctate, the second and third with a transverse impression or furrow near the middle, similar to the Tryphonine genus *Bassus*.

Type.—Cat. No. 8047, U.S.N.M.

Manila. (W. A. Stanton.)

Genus BATHRYTHRIX Förster.

BATHRYTHRIX STRIATUS, new species.

Female.—Length 5 mm. Ovipositor hardly as long as the abdominal petiole. Head black, the thorax and abdomen, except segments 4 to 6, pale ferruginous; the third segment above is more or less dusky; the fourth and following, except narrowly at apex, are black; the face and clypeus are clothed with silvery white hairs; the first and second joints of the antennæ and flagellar joints 1 to 7 beneath are honey-yellow, the rest of antennæ brown black; legs pale ferruginous, the hind tibiæ with a white annulus at base; the rest of tibiæ, the apex of hind femora, and the hind tarsi black or dark fuscous. Wings hyaline, with a broad fuscous fascia across the front wings from the stigma; the stigma and veins dark brown or blackish, the parastigma whitish. The abdomen is longitudinally striated.

Type.—Cat. No. 7917, U.S.N.M.

Manila. One specimen. (W. A. Stanton.)

Genus PARAPHYLAX Förster.

PARAPHYLAX FASCIATIPENNIS, new species.

Male.—Length 3.5 mm. Polished black, shining; the first joint of the antennæ and the legs, except as hereafter noted, honey-yellow; palpi and trochanters ivory-white; hind coxæ black, the apical two-thirds of hind tibiæ and more or less of their tarsi fuscous. Wings hyaline, with a broad fuscous band across the front wings from the stigma.

Type.—Cat. No. 7918, U.S.N.M.

Manila. (W. A. Stanton.)

Genus DIATORA Förster.

DIATORA PRODENIÆ, new species.

Female.—Length 2.5 mm. Head, thorax, and first segment of abdomen polished black, shining; the metathorax above rugulose, completely areolated; the rest of the abdomen ferruginous, dusky at sides toward apex, the second and third dorsal segments yellowish; the

flagellum is fuscous or blackish, the first joint beneath, the scape and pedicel, and the legs, except a spot at base of hind tibiæ and the hind tarsi, which are fuscous, are bright brownish-yellow. Wings hyaline, the stigma and veins brown.

Type.—Cat. No. 7919, U.S.N.M.

Manila. Two specimens. (Father W. A. Stanton.)

Tribe VI. CRYPTINI.

Genus AGROTHEREUTES Förster.

To this genus I should relegate *Cryptus verticalis* Bingham, which is not a true *Cryptus*. *Cryptus præpes* Bingham is unknown to me and very difficult to place generically from the description; it is certainly no *Cryptus* and belongs evidently in the tribe *Phygadeuonini*. It may be placed temporarily, or until I can secure a specimen for examination, in *Microcryptus* Thomson, where I think it belongs.

AGROTHEREUTES UNIFASCIATUS, new species.

Female.—Length 8.5 mm. Head, prothorax and mesothorax, basal two-thirds of second dorsal abdominal segment, and the third, fourth, fifth, and sixth segments, black; the scape beneath, the mesopleura posteriorly, the metathorax, and the legs, except as noted, are ferruginous; the palpi, the base of mandibles, the tegulæ, a spot beneath them, the scutellum, the front coxæ, except at base, the hind tarsi, except base and apex of the first joint and the apices of the following joints, the apex of the first and second dorsal abdominal segments, and the seventh and eighth segments ivory-white. Wings hyaline, the front wings with their apices, and a band across from the apical half of the stigma, fuscous.

Type.—Cat. No. 7920, U.S.N.M.

Manila. (Father Stanton.)

AGROTHEREUTES ALBICOXIS, new species.

Female.—Length 7.5 mm. Ovipositor about one-third the length of the abdomen. Black, marked with white as follows: Antennal joints 6 to 14 beneath, the inner orbits broadly, the face below the antennæ, the clypeus, the mandibles except teeth, the palpi, the upper ridge of the collar, the hind margin of the pronotum to the tegulæ, narrowed medially; the tegulæ, a spot beneath, the scutellum, the postscutellum, the apex of the metathorax, a broad stripe on each side; the front and middle coxæ and trochanters, tibial spurs and hind tarsi, except the last joint, bands at apex of dorsal abdominal segments 1 to 4, a streak on each side of the fifth, a streak at apex of the sixth, the seventh and eighth entirely, and the ventral segments, except black

lateral marks, all ivory-white. Wings hyaline, the stigma and veins black, the areolet rather small, pentagonal.

Type.—Cat. No. 8004, U.S.N.M.

Manila. (W. A. Stanton.) Allied to *A. unifasciatus* in structure, but differs decidedly in color of thorax and abdomen, and in having no fuscous band on the front wings.

Tribe VII. MESOSTENINI.

Genus MESOSTENOIDEUS Ashmead.

MESOSTENOIDEUS OCTOZONATUS, new species.

Female.—Length 9.5 mm. Ovipositor a little shorter than the abdomen. Black, marked with white as follows: Joints 7 to 11 of antennæ, the palpi, a spot on the mandibles, the clypeus and the face to the insertion of the antennæ, the inner orbits, the cheeks and hind orbits interrupted above, a transverse line on the collar, the upper margin of the pronotum broadly interrupted medially, a spot on the middle mesothoracic lobe posteriorly, a streak on the lateral ridges of the scutellum, a spot on the scutellum and the lateral ridge from its apex, the post-scutellum and its lateral ridges, the tegulæ, a spot beneath, two spots on the mesopleura, a lateral spot on the mesosternum, the front coxæ more or less, two spots on the metapleura, a spot near the middle of the metanotum, a spot enclosing the metathoracic teeth, and bands at the apex of dorsal segments 4 to 8 of abdomen, white; the white bands on segments 4 to 8 are interrupted at the middle; the ventral segments are also white at apex; legs yellowish-red; the hind tarsi with joints 2 to 5 fuscous. Wings hyaline, the stigma and veins black, the areolet small, closed, longer than wide, the second recurrent nervure interstitial, or very nearly, with the second transverse cubitus.

Type.—Cat. No. 8005, U.S.N.M.

Manila. (Father W. A. Stanton.)

Subfamily III. PIMPLINÆ.

Tribe III. LISSONOTINI.

Genus ATROPHA Kriechbaumer.

ATROPHA CLYPEARIA, new species.

Female.—Length 6 to 8 mm. (very variable in size); ovipositor about as long as the abdomen. Black and shining, marked with white as follows: The mandibles, except the teeth, the clypeus, a small spot on the malar space, a line on the face next to the eyes, a triangular spot on inner orbits above the insertion of the antennæ, the scape beneath, basal joints of palpi, a wedge-shaped spot on each side of the mesonotum anteriorly, the tegulæ, a spot beneath, a spot at the inser-

tion of the hind wings, the scutellum, a spot on metathorax just above the hind coxæ, the front coxæ and trochanters, an annulus at base of hind tibiæ and tarsi, the base of the first abdominal segment, a band at base of the second and third segments, and a band at apex of the third, all white; rest of the legs, except the hind femora toward apex, the hind tibiæ, the tibial spurs, and the tarsi, which are fuscous, red. Wings hyaline, with a large fuscous blotch just before apex, the stigma and veins blackish or dark fuscous. The thorax anteriorly is finely punctate, shining; the metathorax coarser and more closely punctate, without carinæ, and opaque.

Male.—Differs in having the white line on the face dilated and connected with the spot on the upper orbits, leaving a triangular black spot beneath the antennæ, while the apices of abdominal segments 2 to 5, as well as a band at the base, are white.

Type.—Cat. No. 8006, U.S.N.M.

Manila. Described from 2 female and 2 male specimens (W. A. Stanton).

Subfamily V. OPHIONINÆ.

Tribe IV. ANOMALINI.

Genus ATROMETUS Förster.

ATROMETUS MINUTUS, new species.

Male.—Length 3.5 to 4 mm. Polished black; first four joints of antennæ, the palpi, the tegulæ, the apices of the coxæ, the trochanters and middle tibiæ, and the base of the abdominal petiole, ivory white; rest of legs, except the hind legs, honey-yellow, the hind legs black or fuscous, the hind coxæ beneath and toward apex, and the hind tibiæ beneath and more or less medially, ferruginous; the hind femora medially are also sometimes ferruginous. The abdominal segments 1, 2, 3, and 4 at base are pale yellowish, or whitish; otherwise, except the ventral segments 1 to 4, the abdomen is black or blackish.

Type.—Cat. No. 7921, U.S.N.M.

Manila. Three specimens (W. A. Stanton).

Tribe VIII. MESOCHORINI.

Genus MESOCHORUS Gravenhorst.

MESOCHORUS PHILIPPINENSIS, new species.

Female.—Length 1.9 mm. Luteous, the head above tinged with reddish, the ocelli on a black spot, the mesonotum, except a spot just in front of the scutellum, blackish; palpi, coxæ, trochanters, tibial spurs, and the hind tibiæ, except at base and apex, whitish, the base and apex of the hind tibiæ fuscous; abdomen above blackish, the apex

of the petiole, a large oval spot on the second and third segments, and the apical three segments luteous or yellowish white. Wings hyaline, the costal vein and stigma dark brown.

Type.—Cat. No. 7922, U.S.N.M.

Manila. One specimen (W. A. Stanton).

Tribe X. PRISTOMERINI.

Genus PRISTOMERUS Holmgren.

PRISTOMERUS FLAVUS, new species.

Male.—Length 6 mm. Uniformly brownish yellow, except the apex of the metathorax and the base of the abdominal petiole, which are slightly whitish; the flagellum, the costal veins, except at base, and the stigma are brown-black; eyes greenish; hind tarsi fuscous. Wings hyaline, the internal veins brownish.

Type.—Cat. No. 7923, U.S.N.M.

Manila. (W. A. Stanton.)

Family LXXVIII. BRACONIDÆ.

Subfamily V. MACROCENTRINÆ.

Tribe I. MACROCENTRINI.

Genus MACROCENTRUS Curtis.

MACROCENTRUS PHILIPPINENSIS, new species.

Female.—Length 7.5 mm.; ovipositor longer than the abdomen. Black and shining, the scape beneath, the palpi, front coxæ and trochanters, a broad band at base of hind tibiæ, a band at base of metathorax and enclosing most of the metapleura, and a band at base of the first and third abdominal segments, yellowish white; legs ferruginous, the hind femora, their tibiæ, except the white band at base, and their tarsi, except the annulus at base of the first joint, black or fuscous. Wings hyaline, the stigma and veins, except the apex of the parastigma, and the poststigmatal vein, which are pale or whitish, brown-black.

Type.—Cat. No. 8007, U.S.N.M.

Manila. One specimen (W. A. Stanton).

Subfamily VI. HELCONINÆ.

Tribe I. HELCONINI.

Genus EUSCELINUS Westwood.

EUSCELINUS MANILÆ, new species.

Female.—Length 2.8 mm. Black, the mesonotum brownish; basal two or three joints of the antennæ, the tegulæ, the legs, except the

apical two-thirds of the greatly swollen and finely serrated hind femora and an annulus on the hind tibiae, which are black or dark fuscous, and the second abdominal segment, testaceous; the front legs and the base of the hind tibiae are yellowish; the flagellum is brown, becoming blackish toward apex; the ovipositor is yellowish, with the apical third black and a little longer than the abdomen. Wings hyaline.

Type.—Cat. No. 8009, U.S.N.M.

Manila. One specimen. (Robert Brown.)

Subfamily IX. CHELONINÆ.

Genus CHELONUS Jurine.

CHELONUS SEMIHYALINUS, new species.

Female.—Length 3.5 mm. Black, rather coarsely punctured, the abdomen with a transverse white band at base; the front tibiae basally, all tibial spurs, and an annulus on the hind tibiae near the base are white; the basal half of the front wings and the hind wings entirely are hyaline, the apical half of the front wings being fuscous.

Type.—Cat. No. 7924, U.S.N.M.

Manila. (W. A. Stanton.)

Subfamily X. AGATHIDINÆ.

Tribe I. AGATHIDINI.

Genus CREMNOPS Förster.

CREMNOPS COLLARIS, new species.

Female.—Length 6.5 mm.; ovipositor the length of the abdomen. Black, but with the head anteriorly from the antennae, the prothorax, the front legs, except the tibiae and the middle coxae, honey-yellow; the apices of the second and third ventral segments are pale. Wings blackish fuscous, with a hyaline spot at the apex of the submedian cell, another across from the first cubital cell, and another across before the apex of the front wing.

Male.—Length 6 mm. In this sex the head and prothorax are sometimes wholly black or only yellowish anteriorly; the legs darker, wholly black, or with only the front coxae and tarsi yellowish-white; the front wings, too, are darker, with usually only a hyaline spot across from the first cubital cell.

Type.—Cat. No. 7925, U.S.N.M.

Manila. Several specimens. (W. A. Stanton.)

Tribe II. MICRODINI.

STANTONIA, new genus.

This interesting new genus falls naturally in this tribe, but shows some affinity with the genus *Meteoridea* Ashmead.

The marginal cell is very large, lanceolate, and extends to the apex of the wing, an unusual character in the subfamily *Agathidinæ*; the

areolet is triangular, the median and submedian cells being of an equal length; otherwise, in the structure of the head, thorax, and in the sessile abdomen, it is similar to *Microdus*. The mouth parts, number of palpal joints, etc., can not be made out in the single specimen, and will have to be described when more specimens are received. The abdomen is compressed toward apex, as in *Zele* Haliday, but the ovipositor is nearly as long as the abdomen, the first and second segments being long, subequal in length, while the following are short, united not longer than the first. If the areolet were removed the front wings would be very similar in venation to that found in the subfamily *Blacinae*.

The genus is dedicated to Father W. A. Stanton, whose discoveries have done so much toward advancing the knowledge of the Philippine hymenopterous fauna.

STANTONIA FLAVA, new species.

Plate I, fig. 2.

Female.—Length 4.5 mm.; ovipositor about as long as the abdomen. Wholly brownish-yellow, the eyes purplish in certain lights, the flagellum brownish; the apices of the hind tibiae, the hind tarsi except the first joint basally, and the sheaths of the ovipositor are black. Wings hyaline, smoky at apex; the stigma and veins are blackish fuscous, and there is a small rounded black spot at the apex of the tegulae. The thorax is normal, with the parapsidal furrows distinct, but that converge and meet just before the base of the scutellum; the metathorax is smooth and without carinae.

Type.—Cat. No. 8008, U.S.N.M.

Manila. One specimen.

Subfamily XII. MICROGASTERINÆ.

Genus GLYPTAPANTELES Ashmead.

GLYPTAPANTELES MANILÆ, new species.

Female.—Length 1.9 mm. Black and shining, faintly sericeous, the head and thorax smooth and impunctate, the metathorax short, without a median carina; the first and second ventral segments and the legs are brownish-yellow, the tips of hind tibiae and the hind tarsi only faintly dusky; the abdomen above is polished, impunctate, the second segment with two oblique grooved lines that converge anteriorly; the plate of the first segment is a little longer than wide, with the sides parallel. Wings hyaline, the stigma brown, the internal veins pallid or hyaline.

Male.—Length 1.5 mm. Scarcely distinguishable from the female, except by the smaller abdomen, which lacks the prominent hypopygium, and by the antennae, which are longer.

Type.—Cat. No. 7926, U.S.N.M.

Manila. Two female and one male specimens. (W. A. Stanton.)

Subfamily XIV. OPIINÆ.

Genus EURYTENES Förster.

EURYTENES NANUS, new species.

Female.—Length, 1 mm. Honey yellow, smooth, and shining, the head above testaceous, the mesonotum and the apical half of the abdomen, black; the eyes, the antennæ, except the scape and an annulus at apex of the pedicel, the tips of the hind femora and their tarsi, are fuscous; scape of antennæ, the annulus on pedicel, and the legs are yellow. Wings hyaline, the stigma and veins dark brown. The antennæ are very long, much longer than the whole insect, and 28-jointed.

Type.—Cat. No. 8011, U.S.N.M.

Manila. (W. A. Stanton.)

Genus OPIUS Wesmæel.

OPIUS PHILIPPINENSIS, new species.

Male.—Length, 1.6 mm. Uniformly brownish yellow, the eyes and antennæ brown, the stemmaticum and the apical two-thirds of the abdomen black; the scape beneath and the pedicel are yellow. Wings subfuliginous, the stigma and veins brown, the tegulæ pale yellowish.

Type.—Cat. No. 8012, U.S.N.M.

Manila. (W. A. Stanton.)

Subfamily XV. BRACONINÆ.

Tribe II. BRACONINI.

Genus BRACON Fabricius.

BRACON RICINICOLA, new species.

Female.—Length, 3 mm.: ovipositor about the length of the abdomen. Brownish-yellow, the sutures of the metathorax, a line down the metanotum, and oblong spots at the base of dorsal abdominal segments three, four, and five, black; the flagellum is fuscous; the mesopleura medially below are dusky. Wings subhyaline, the stigma and veins brown. The abdomen above is finely shagreened.

Type.—Cat. No. 7927, U.S.N.M.

Manila. (W. A. Stanton.)

Subfamily XVII. SPATHIINÆ.

Tribe II. SPATHIINI.

Genus SPATHIUS Nees.

SPATHIUS PHILIPPINENSIS, new species.

Female.—Length, 2.6 mm.; ovipositor about two-thirds the length of the abdomen. Black; the middle mesothoracic lobe, the cheeks,

the apical third of the petiole of the abdomen, and most of the legs are reddish brown; the tarsi, except last joint, whitish; the hind tibiae, dark fuscous; the antennae are very long and slender, much longer than the body, yellowish, but becoming dusky or brown at apex. Wings subfuscous, with the extreme tips, a transverse band at basal third, and another at the apical third, hyaline or whitish; the second band on the wings starts from and includes the basal half of the stigma.

Type.—Cat. No. 8010, U.S.N.M.
Manila. (W. A. Stanton.)

CHECK LIST OF THE PHILIPPINE HYMENOPTERA.

Suborder I. HETEROPHAGA Ashmead.

SUPERFAMILY I. APOIDEA.

FAMILY I. APIDÆ.

Subfamily I. MELIPONINÆ.

Subfamily II. APINÆ.

Genus Megapis Ashmead.

M. zonata Smith.

M. dorsata Fabricius.

Genus Apis Linnæus.

A. mellifera Linnæus.

A. unicolor Latreille.

A. nigrocincta Smith.

Genus Micrapis Ashmead.

M. florea Fabricius.

FAMILY II. BOMBIDÆ.

FAMILY III. EUGLOSSIDÆ.

FAMILY IV. PSITHYRIDÆ.

FAMILY V. ANTHOPHORIDÆ.

Genus Anthophora Latreille.

A. zonata Linnæus.

A. cingulata Fabricius.

FAMILY VI. NOMADIDÆ.

Genus Crocisa Latreille.

C. lamprosoma Boisduval.

C. nitidula Fabricius.

Genus Nomada Scopoli.

N. lusca Smith.

FAMILY VII. CERATINIDÆ.

Genus Ceratina Latreille.

C. compacta Smith.

C. hieroglyphica Smith.

C. philippinensis Ashmead.

Genus Allodape Smith.

A. philippinensis Ashmead.

FAMILY VIII. XYLOCOPIDÆ.

Genus Xylocopa Latreille.

X. bryorum Fabricius.

X. dissimilis Lepeletier.

X. ghilianii Gribodo.

X. philippinensis Smith.

X. bombiformis Smith.

X. trifasciata Gribodo.

Genus Platynopoda Westwood.

P. latipes Drury.

P. tenuicornis Westwood.

FAMILY IX. MEGACHILIDÆ.

Subfamily I. OSMINÆ.

Subfamily II. MEGACHILINÆ.

Genus Megachile Latreille.

M. atrata Smith.

M. laticeps Smith.

M. robbii Ashmead.

FAMILY X. STELIDIDÆ.

Subfamily I. STELIDINÆ.

Subfamily II. COELIOXINÆ.

Genus Coelioxys Latreille.

C. philippinensis Bingham.

FAMILY XI. PANURGIDÆ.

FAMILY XII. ANDRENIDÆ.

Subfamily I. ANDRENINÆ.

Genus *Hoplonomia* Ashmead.*H. quadrifasciata* Ashmead.Genus *Paranomia* Friese.*P. stantoni* Ashmead.

Subfamily II. HALICTINÆ.

Genus *Halictus* Latreille.*H. robbii* Ashmead.

Subfamily III. SPHECODINÆ.

FAMILY XIII. COLLETIDÆ.

FAMILY XIV. PROSOPIDÆ.

SUPERFAMILY II. SPHECOIDEA
Ashmead.

FAMILY XV. OXYBELIDÆ.

FAMILY XVI. CRABRONIDÆ.

Subfamily I. ANACRABRONINÆ.

Subfamily II. LINDENINÆ.

Subfamily III. CRABRONINÆ.

Subfamily IV. THYREOPINÆ.

Subfamily V. RHOPALINÆ.

Genus *Dasyproctus* Lepeletier.*D. philippinensis* Ashmead.Genus *Rhopalum* Kirby.*R. albocollaris* Ashmead.

FAMILY XVII. PEMPHREDONIDÆ.

FAMILY XVIII. BEMBICIDÆ.

FAMILY XIX. LARRIDÆ.

Subfamily I. LARRINÆ.

Genus *Notogonia* Costa.*N. laboriosa* Smith.*N. manicata* Ashmead.

Subfamily IV. PISONINÆ.

Genus *Pison* Spinola.*P. laguna* Ashmead.Genus *Pisonitus* Shuckard.*P. argenteus* Ashmead.

FAMILY XX. PHILANTHIDÆ.

Subfamily I. CERCERINÆ.

Genus *Cerceris* Wesmæl.*C. vafra* Bingham.

FAMILY XXI. TRYPOXYLIDÆ.

Genus *Trypoxylon* Latreille.*T. bicolor* Smith.

FAMILY XXII. MELLINIDÆ.

Genus *Megalomma* Smith.*M. quadricinctum* Ashmead.

FAMILY XXIII. NYSSONIDÆ.

FAMILY XXIV. STIZIDÆ.

FAMILY XXV. SPHECIDÆ.

Subfamily I. SPHECINÆ.

Genus *Sphex* Linnæus.*S. aurulentus* Fabricius.a. var. *ferrugineus* Lepeletier.aa. var. *lineolus* Lepeletier.*S. sericeus* Fabricius.*S. umbrosus* Christ.a. var. *rufipennis* Fabricius.aa. var. *plumiferus* Costa.*S. sulciscutula* Gribodo.Genus *Chlorion* Latreille.*C. lobotum* Fabricius.

Subfamily II. AMMOPHILINÆ.

Genus *Ammophila* Kirby.*A. atripes* Smith.*A. corinata* Costa.*A. superciliaris* Saussure.

Subfamily III. SCELIPHRONINÆ.

Genus Sceliphron Smith.

S. violaceum Fabricius.*S. madraspatanum* Fabricius.var. *S. conspicillatum* Costa.

Genus Chalybion Dahlbom.

C. violaceum Dahlbom.

FAMILY XXVI. AMPULICIDÆ.

Subfamily I. DOLICHURINÆ.

Subfamily II. AMPULICINÆ.

Genus Ampulex Jurine.

A. compressa Fabricius.*A. laevigata* Kohl.

SUPERFAMILY III. VESPOIDEA.

FAMILY XXVII. CEROPALIDÆ.

Subfamily I. PEPSINÆ.

Genus Salix Fabricius.

S. flavus Fabricius.*S. graphicus* Smith.

Genus Hemipepsis Dahlbom.

H. tagala Gribodo.

Genus Pallosoma Lepeletier.

P. fulgidipennis Saussure.

Genus Pseudosalius Ashmead.

P. bipartitus Lepeletier.

Genus Calicurgus Lepeletier.

C. sericosoma Smith.

Subfamily II. AGENIINÆ.

Genus Macromeris Lepeletier.

M. violacea Lepeletier.

Genus Pseudagenia Kohl.

P. unifasciata Ashmead.

Genus Agenia Schiödt.

A. cingulata Ashmead.

Subfamily III. APORINÆ.

Tribe I. ANOPLIINI.

FAMILY XXVIII. VESPIDÆ.

Subfamily I. VESPINÆ.

Genus Vespa Linnaeus.

V. deusta Lepeletier.*V. cincta* Fabricius.*V. luctuosa* Saussure.*V. nigripennis* Saussure.*V. philippinensis* Saussure.

Genus Provespa Ashmead.

P. dorylloides Saussure.

Subfamily II. POLISTINÆ.

Genus Polistella Ashmead.

P. manillensis Saussure.

Genus Polistes Latreille.

P. dubius Saussure.*P. philippinensis* Saussure.*P. hebraeus* Fabricius.

Genus Icaria Saussure.

I. philippinensis Saussure.

FAMILY XXIX. EUMENIDÆ.

Subfamily I. ISCHNOGASTERINÆ.

Subfamily II. DISCELINÆ.

Subfamily III. RAPHIGLOSSINÆ.

Subfamily IV. EUMENINÆ.

Tribe I. EUMENINI.

Genus Eumenes Fabricius.

E. conica Fabricius.*E. curvata* Saussure.*E. fulripennis* Smith.*E. gracilis* Saussure.

Tribe II. ODYNERINI.

Genus *Rhynchium* Spinola.*R. atrum* Saussure.Genus *Leionotus* Saussure.*L. dyschirus* Saussure.*L. punctum* Saussure.Genus *Ancistrocerus* Saussure.*A. bizonatus* Boisduval.

FAMILY XXX. MASARIDÆ.

FAMILY XXXI. CHRYSIDIDÆ.

Subfamily II. CHRYSIDINÆ.

Genus *Stilbum* Spinola.*S. amethystinum* Fabricius.*S. splendidum* Fabricius.Genus *Chrysus* Linnæus.*C. fuscipennis* Brullé.Genus *Trichrysis* Lichtenstein.*T. aspera* Brullé.

FAMILY XXXII. BETHYLIDÆ.

Subfamily I. BETHYLINÆ.

Genus *Dissomphalus* Ashmead.*D. tibialis* Ashmead.Genus *Goniozus* Förster.*G. philippinensis* Ashmead.

Subfamily II. EMBOLEMINÆ.

Subfamily III. DRYININÆ.

Genus *Dryinus* Latrié.*D. stantoni* Ashmead.

FAMILY XXXIII. TRYGONALIDÆ.

Genus *Trigonalys* Westwood.*T. lachymosa* Westwood.

FAMILY XXXIV. SAPYGIDÆ.

FAMILY XXXV. MYZINIDÆ.

FAMILY XXXVI. SCOLIIDÆ.

Subfamily I. SCOLINÆ.

Genus *Discolia* Saussure.*D. erratica* Smith.*D. aureipennis* Lepeletier.*D. modesta* Smith.Genus *Scolia* Fabricius.*S. capitata* Guérin.*S. whiteheadii* Bingham.*S. procera* Illiger.*S. manille* Ashmead.

Subfamily II. ELIDINÆ.

Genus *Elis* Fabricius.*E. aureicollis* Lepeletier.*E. annulata* Fabricius.*E. grossa* Fabricius.*E. luctuosa* Smith.*E. quadrifasciata* Fabricius=*E. lindeni* Lepel.*E. albicollis* Christ=*E. thoracica* Smith.*E. reticulata* Cameron.Genus *Liacos* Guérin.*L. analis* Fabricius.

FAMILY XXXVII. TIPHIIDÆ.

Genus *Tiphia* Fabricius.*T. compressa* Smith.

FAMILY XXXVIII. COSILIDÆ.

FAMILY XXXIX. RHOPALOSOMIDÆ.

FAMILY XL. THYNNIDÆ.

FAMILY XLI. MYRMOSIDÆ.

FAMILY XLII. MUTILLIDÆ.

Subfamily I. MATILLINÆ.

Tribe I. PHOTOPSIDINI.

Tribe II. MUTILLINI.

Genus *Mutilla* Linnæus.*M. nigra* Smith.*M. philippinensis* Smith.*M. semperi* Ashmead.*M. suspiciosa* Smith.

SUPERFAMILY IV. FORMICOIDEA.

FAMILY XLIII. DORYLIDÆ.

FAMILY XLIV. PONERIDÆ.

Genus *Diacaulna* Mayr.*D. versicolor* Smith.Genus *Odontoponera* Mayr.*O. denticulata* Smith.

FAMILY XLV. ODONTOMACHIDÆ.

Genus *Odontomachus* Latreille.*O. infandus* Smith.

FAMILY XLVI. MYRMICIDÆ.

Genus *Sima* Roger.*S. allaborans* Walker.Genus *Pheidologiton* Mayr.*P. diversus* Jerdon.Genus *Plagiolepis* Mayr.*P. longipes* Jerdon.Genus *Tetramorium* Mayr.*P. guineensis* Talrimis.

FAMILY XLVII. CRYPTOCERIDÆ.

FAMILY XLVIII. DOLICHODERIDÆ.

Genus *Dolichoderus* Lund.*D. bituberculatus* Mayr.Genus *Technomyrmex* Mayr.*T. allipes* Smith.

FAMILY XLIX. FORMICIDÆ.

Genus *Camponotus* Mayr.*C. cinerascens* Fabricius.*C. gigas* Latreille.*C. pallidus* Smith.Genus *Formica* Linnaeus.*F. rubra* Fabricius.Genus *Polyrhachis* Swainson and Shuckan.*P. aciculata* Smith.*P. abdominalis* Smith.*P. armata* Le Guillon.*P. bellicosa* Smith.*P. bicolor* Smith.*P. bihamata* Drury.*P. cyaniventris* Smith.*P. dives* Smith.*P. maligna* Smith.*P. mayri* Roger.*P. philippinensis* Smith.*P. rastellata* Smith.*P. sexspinosa* Latreille.

SUPERFAMILY V. PROCTOTRYPOIDEA.

FAMILY L. PELECINIDÆ.

FAMILY LI. HELORIDÆ.

FAMILY LII. PROCTOTRYPIDÆ.

FAMILY LIII. BELYTIDÆ.

FAMILY LIV. DIAPRIIDÆ.

FAMILY LV. CERAPHRONIDÆ.

Genus *Ceraphron* Jurine.*C. manille* Ashmead.

FAMILY LVI. SCHELIONIDÆ.

Subfamily I. *TELENOMINÆ*.Subfamily II. *BAEINÆ*.Subfamily III. *TELEASINÆ*.Subfamily IV. *SCHELIONINÆ*.Genus *Hadronotus* Förster.*H. philippinensis* Ashmead.

FAMILY LVII. PLATYGASTERIDÆ.

SUPERFAMILY VI. CYNIPOIDEA.

FAMILY LVIII. FIGITIDÆ.

Subfamily VI. *XYSTINÆ*.Genus *Loboscelidia* Westwood.*L. rufescens* Westwood.

FAMILY LIX. CYNIPIDÆ.

SUPERFAMILY VII. CHALCIDOIDEA.

FAMILY LX. AGAONIDÆ.

FAMILY LXI. TORYMIDÆ.

FAMILY LXII. CHALCIDIDÆ.

Subfamily I. LEUCOSPIDINÆ.

Genus *Leucospis* Fabricius.

L. regalis Westwood.

Subfamily II. CHALCIDINÆ.

Tribe I. CHALCIDINI.

Genus *Chalcis* Linnaeus.

C. albotibialis Ashmead.

C. argentifrons Ashmead.

C. prodeniæ Ashmead.

C. pulchripes Holmgren.

C. verruca Walker.

Tribe II. SMICRINI.

Tribe III. CHALCITELLINI.

Genus *Arretocera* Kirby.

A. stantoni Ashmead.

Tribe IV. HALTICHELLINI.

Genus *Neochalcis* Kirby.

N. tarsalis Walker.

Genus *Haltichella* Spinola.

H. nasuta Holmgren.

H. validicornis Holmgren.

H. ludlowæ Ashmead.

Tribe V. DIRHININI.

Genus *Dirhinus* Dalman.

D. anthracia Walker.

FAMILY LXIII. EURYTOMIDÆ.

Tribe I. AXIMINI.

Tribe II. ISOSOMINI.

Tribe III. EURYTOMINI.

Genus *Eurytoma* Illiger.

E. manila Ashmead.

Tribe IV. RILEYINI.

Tribe V. DECATOMINI.

FAMILY LXIV. PERILAMPIDÆ.

FAMILY LXV. EUCHARIDÆ.

Genus *Chalcura* Kirby.

C. aegincta Walker.

C. nasua Walker.

FAMILY LXVI. MISCOGASTERIDÆ.

Subfamily I. PIRENINÆ.

Subfamily II. TRIDYMINÆ.

Subfamily III. MISCOGASTERINÆ.

Subfamily IV. LELAPINÆ.

FAMILY LXVII. CLEONYMIDÆ.

Subfamily I. CHALCEDECTINÆ.

Subfamily II. CLEONYMINÆ.

Genus *Epistenia* Westwood.

E. ania Walker.

E. feretius Walker.

FAMILY LXVIII. ENCYRTIDÆ.

Subfamily I. EUPELMINÆ.

Tribe I. EUPELMINI.

Genus *Metapelma* Westwood.

M. gloriosa Westwood.

Genus *Calosoter* Walker.

C. amenetus Walker.

Genus *Anastatus* Motschulsky.

A. stantoni Ashmead.

Tribe II. TANAOSTIGMINI.

Subfamily II. ENCYRTINÆ.

Tribe I. ECTROMI I.

Genus *Taitia* Ashmead.

T. prodeniæ Ashmead.

Tribe II. ENCYRTINI.

Tribe III. MIRINI.

Genus Coccidencyrthus Ashmead.

C. manilæ Ashmead.

Genus Aphidencyrthus Ashmead.

A. pallidipes Ashmead.

Genus Exoristobia Ashmead.

E. philippinensis Ashmead.

FAMILY LXIX. PTEROMALIDÆ.

Subfamily I. PTEROMALINÆ.

FAMILY LXX. ELASMIDÆ.

Genus Elasmus Westwood.

E. philippinensis Ashmead.

FAMILY LXXI. EULOPHIDÆ.

Subfamily I. ENTEDONINÆ.

Tribe I. TETRACAMPINI.

Tribe II. OPHELININI.

Genus Closterocerus Westwood.

C. brownii Ashmead.

Tribe III. ENTEDONINI.

Genus Asecodes Förster.

A. elasmii Ashmead.

Subfamily II. APHELININÆ.

Tribe I. APHELININI.

Genus Aspidiotiphagus Howard.

A. aleyrodis Ashmead.

Subfamily III. TETRASTICHINÆ.

Tribe I. CERATONEURINI.

Tribe II. TETRASTICHINI.

Genus Tetrastichus Haliday.

T. philippinensis Ashmead.

Subfamily IV. ELACHERTINÆ.

Tribe I. EUPLECTRINI.

Genus Euplectrus Westwood.

E. manilæ Ashmead.*E. philippinensis* Ashmead.

SUPERFAMILY VIII. ICHNEUMONOIDEA.

FAMILY LXXIV. EVANIIDÆ.

Genus Evania Fabricius.

E. annulipes Ashmead.*E. appendigaster* Linnaeus.*E. impressa* Schletterer.*E. verrucosa* Schletterer.

FAMILY LXXV. AGRIOTYPIDÆ.

FAMILY LXXVI. ICHNEUMONIDÆ.

Subfamily I. ICHNEUMONINÆ.

Tribe I. JOPPINI.

Tribe II. ICHNEUMONINI.

Tribe III. LISTRODROMINI.

Tribe IV. HERESIARCHINI.

Tribe V. ALOMYINI.

Tribe VI. PHÆOGENINI.

Subfamily II. CRYPTINÆ.

Tribe I. STILPNINI.

Tribe II. PHYGADEUONINI.

Genus Microcryptus Thomson.

M. praeipes Bingham.

Genus Astomaspis Förster.

A. metathoracica Ashmead.

Genus Coryphus Holmgren.

C. apicalis Holmgren.

Tribe III. HEMITELINI.

Genus Otacustes Förster.

O. alboannulus Ashmead.

Genus Bathytrix Förster.

B. striatus Ashmead.

Genus Paraphylax Förster.

P. fasciatipennis Ashmead.

Genus Diatora Förster.

D. prodeniæ Ashmead.

Tribe IV. PEZOMACHINI.

Tribe V. HEMIGASTERINI.

Tribe VI. CRYPTINI.

Genus *Agrothereutes* Förster.*A. unifasciatus* Ashmead.*A. albicoris* Ashmead.*A. verticalis* Bingham.

Tribe VII. MESOSTENINI.

Genus *Mesostenoides* Ashmead.*M. octozonatus* Ashmead.*M. philippinensis* Ashmead.*M. literatus* Brullé.*M. marginatus* Brullé.

Subfamily III. PIMPLINÆ.

Tribe I. ACÆNITINI.

Tribe II. LABENINI.

Tribe III. LISSONOTINI.

Genus *Atropha* Kriechbaumer.*A. clypearia* Ashmead.

Tribe IV. PIMPLINI.

Genus *Pimpla*.*P. punctum* Brullé.

Tribe V. XORIDINI.

Genus *Calliclisis* Förster.*C. furcifer* Bingham.

Subfamily IV. TRYPHONINÆ.

Tribe I. MESOLEPTINI.

Subfamily V. OPHIONINI.

Tribe I. HELLWIGIINI.

Tribe II. OPHIONINI.

Genus *Enicospilus* Curtis.*E. ashbyi* Ashmead.

Tribe III. NOTOTRACHINI.

Tribe IV. ANOMALINI.

Genus *Atrometus* Förster.*A. minutus* Ashmead.

Tribe V. CAMPOPLEGINI.

Tribe VI. PANISCINI.

Tribe VII. BANCHINI.

Tribe VIII. MESOCHORINI.

Genus *Mesochorus* Gravenhorst.*M. philippinensis* Ashmead.

Tribe IX. PORIZONINI.

Genus *Leptopygus* Förster.*L. stangli* Ashmead.Genus *Temelucha* Förster.*T. philippinensis* Ashmead.

Tribe X. PRISTOMERINI.

Genus *Pristomerus* Holmgren.*P. flavus* Ashmead.

Tribe XI. CREMASTINI.

Tribe X. PLECTISCINI.

FAMILY LXXVII. ALYSIIDÆ.

FAMILY LXXVIII. BRACONIDÆ.

Subfamily I. APHIDINI.

Subfamily II. PAXYLLOMINÆ.

Subfamily III. EUPHORINÆ.

Subfamily IV. METEORINÆ.

Genus *Meteorus* Haliday.*M. bacoorensis* Ashmead.

Subfamily V. MACROCENTRINÆ.

Tribe I. MACROCENTRINI.

Genus *Macrocentrus* Curtis.*M. philippinensis* Ashmead.

Tribe II. ZELINI.

Subfamily VI. HELCONINÆ.

Tribe I. HELCONINI.

Genus *Euscelinus* Westwood.*E. manila* Ashmead.

Tribe II. DIOSPILINI.

Subfamily VII. BLACINÆ.

Subfamily VIII. SIGALPHINÆ.

Subfamily IX. CHELONINÆ.

Genus *Chelonus* Jurine.*C. semihyalinus* Ashmead.Genus *Phanerotoma* Wesmael.*P. philippinensis* Ashmead.

Subfamily X. AGATHIDINÆ.

Tribe I. AGATHIDINI.Genus *Cremnops* Förster.*C. collaris* Ashmead.**Tribe II. MICRODINI.**Genus *Stantonia* Ashmead.*S. flava* Ashmead.

Subfamily XI. CARDIOCHILINÆ.

Subfamily XII. MICROGASTERINÆ.

Genus *Glyptapanteles* Ashmead.*G. manilæ* Ashmead.Genus *Apanteles* Förster.*A. philippinensis* Ashmead.*A. manilæ* Ashmead.Genus *Urogaster* Ashmead.*U. philippinensis* Ashmead.*U. stantoni* Ashmead.Genus *Microplitis* Förster.*M. manilæ* Ashmead.*M. philippinensis* Ashmead.

Subfamily XIV. OPINÆ.

Genus *Eurytenes* Förster.*E. nanus* Ashmead.Genus *Opius* Wesmael.*O. philippinensis* Ashmead.

Subfamily XV. BRACONINÆ.

Tribe I. APHRASTOBRACONINI.**Tribe II. BRACONINI.**Genus *Iphiaulax* Förster.*I. luteifrons* Brullé.*I. nigrifrons* Brullé.*I. deceptor* Smith.Genus *Bracon* Fabricius.*B. ricinicola* Ashmead.

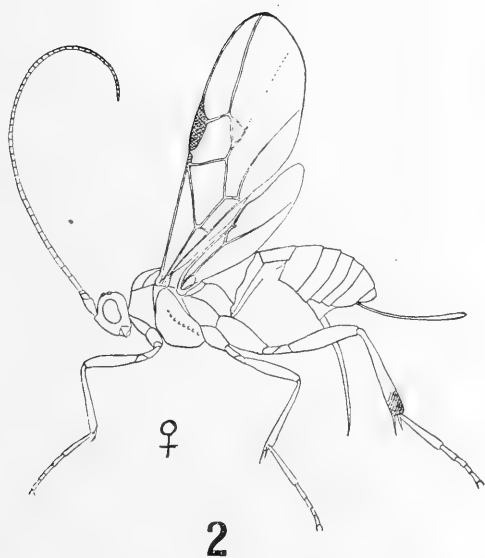
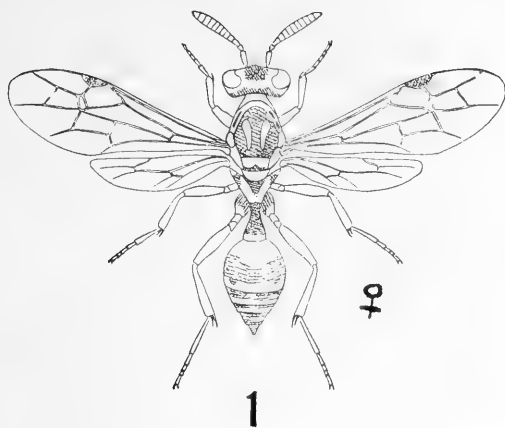
Subfamily XVI. RHOGADINÆ.

Tribe I. EXOTHECINI.**Tribe II. RHYSSALINI.****Tribe III. RHOGADINI.****Tribe IV. DORYCTINI.****Tribe V. HECABOLINI.**

Subfamily XVII. SPATHINÆ.

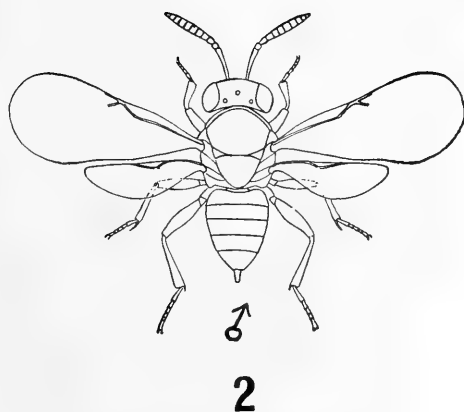
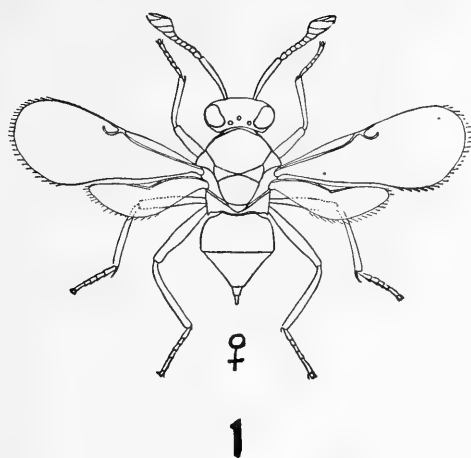
Tribe I. PAMBOLINI.Genus *Monolexis* Förster.*M. manilensis* Ashmead.**Tribe II. HORMIINI.****Tribe III. SPATHIINI.**Genus *Spathius* Nees.*S. philippinensis* Ashmead.**FAMILY LXXIX. STEPHANIDÆ.**Genus *Stephanus* Jurine.*S. coronator* Fabricius.*S. indicus* Westwood.*S. nigricaudus* Sichel.*S. sulcifrons* Schletterer.*S. tarsatus* Schletterer.*S. unicolor* Sichel.**Suborder II. PHYTOPHAGA.****SUPERFAMILY IX. SIRICOIDEA.****FAMILY LXXX. ORYSSIDÆ.**Genus *Oryssus* Latreille.*O. maculipennis* Smith.

FAMILY LXXXI. SIRICIDÆ.	FAMILY LXXXVIII. PERRYIIDÆ.
Genus Tremex Jurine.	FAMILY LXXXIX. PTERYGOPHORIDÆ.
<i>T. nigricollis</i> Westwood.	
FAMILY LXXXII. NIPHYDRIDÆ.	FAMILY LXC. SELANDRIIDÆ.
FAMILY LXXXIII. CEPHIDÆ.	Genus Senoclia Cameron.
SUPERFAMILY X. TENTHREDINOIDEA.	<i>S. albocerulea</i> Bingham.
FAMILY LXXXIV. NYELIDÆ.	FAMILY LXCI. NEMATIDÆ.
FAMILY LXXXV. LYDIDÆ.	FAMILY LXCH. DINEURIDÆ.
FAMILY LXXXVI. HYLOTOMIDÆ.	FAMILY LXCH. TENTHREDINIDÆ.
FAMILY LXXXVII. LOPHYRIDÆ.	FAMILY LXCIV. CIMBICIDÆ.



1. *POLISTELLA MANILLENSIS* SAUSSURE. (SEE PAGE 133.)
2. *STANTONIA FLAVA*, NEW SPECIES. (SEE PAGE 147.)





TAFTIA PRODENIÆ ASHMEAD.

FOR EXPLANATION OF PLATE SEE PAGE 137.

ON THE SYSTEMATIC RELATIONS OF THE AMMODYTOID FISHES.

By THEODORE GILL,

Honorary Associate in Zoology.

There are few fishes respecting whose affinities there has been so much diversity of opinion, especially in later years, as the Sand Launces or Ammodytids. By Artedi, the genus embracing them (*Ammodytes*) was referred next to *Coryphæna*, and by Linnæus it was naturally placed in the unnatural order of Apodes, no ventral fins being developed. For the same reason it was referred by later ichthyologists who adopted families to the same family as other apodal fishes with long dorsal and anal fins. By all except Bonaparte, during the first half of the nineteenth century, it was associated with *Ophidium* in the same family.

In 1846 Bonaparte first separated the genus from the family of Ophidiids, but retained it near that group.

In 1861 Gill adopted the family under the name *Ammodytoideæ*, modifying the name in accordance with the principle promulgated by Agassiz, who insisted that all family names derived from the Greek should have the termination “-oidæ.” The family was removed from association with the “*Ophidioidæ*” and placed next after *Atherinoidæ*, which succeeded *Mugiloidæ* and *Polynematoidæ*. Subsequently (1872) he reverted to the current views, approximating it to the Ophidiids, but isolating it as the representative of a distinct superfamily—*Ammodytoidea*.

In 1896 Jordan and Evermann (p. 832) isolated the *Ammodytidae* as a “group *Ammodytoidei*” after the *Sphyrænidæ* and *Polynemidæ* and before the *Berycoidei*, adding that the group “is of unknown relations.” “In the character of the mouth and gill structures it resembles

the *Atherinidae* rather than the *Ophidioidae*." "The family is placed by Jordan and Gilbert between the *Percesoces* and the *Scombroidei*. Knowing no better place for it we leave it next to the *Percesoces*."

In 1901 A. Smith Woodward, acting under the advice of A. Boulenger,^a referred the family to the *Percesoces*, next before the *Scombroidei* and after the extinct *Crossognathidae*, in the first section of the suborder, the second embracing those having "pelvic fins with anterior spine."

In 1903 David Starr Jordan isolated in a distinct genus (*Embolichthys*) a fish previously described by Jordan and Evermann (1902) as *Bleekeria mitsukurii*. So similar is it to *Bleekeria*, and therefore to *Ammodytes*, that the existence of jugular ventral fins was at first overlooked. Later they were discovered and the bearing of their existence on the question of relationship of the family considered. Their presence, Jordan declared, "shows that the *Ammodytidae* have no affinity with the *Percesoces*, nor with the extinct family of *Cobitopsidae*. Their

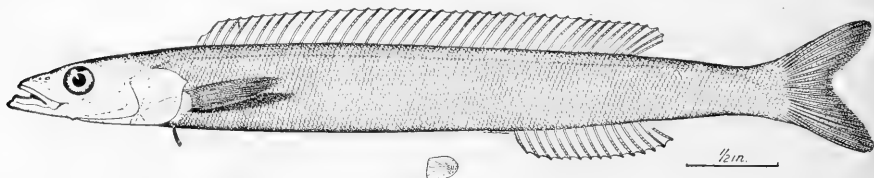


FIG. 1.—EMBOLICHTHYS MITSUKURII.

place must be near the *Ophidiidae*, as supposed by earlier and some recent writers."

In 1904 Boulenger reiterated the views published by Woodward, combining *Scombroidei* and *Ammodytidae* alone in a first section of the suborder *Percesoces*.

The discovery of jugular ventrals in *Embolichthys* is extremely important and conclusively demonstrates (that genus being undoubtedly related to *Ammodytes*) that the family is not at all related to the *Percesoces* and that the affiliation, with the family, of the extinct *Cobitopsis* was misjudged. The question then recurs, What is the relationship of the family? An examination of various species of *Ammodytids* reminded the writer of the genus *Heimerocetes*, of New Zealand. That remarkable genus has a form considerably like an *Ammodytid*'s; all the dorsal rays are simple but articulated, and curiously the supra-maxillaries are produced into anterior spiniform tips. The condition of the scapular arch, however, appears to be different; nevertheless the resemblance in many respects is so great as to demand a comparative anatomical investigation.

^a"For the determination of the systematic position of this genus, the writer is indebted to Mr. G. A. Boulenger." (A. Smith Woodward, IV, p. 354.)

The genera *Hemerocetes* and *Trichonotus* have been associated by all authors except the writer in the same family—Trichonotidæ—but their relationship, if such it be, requires verification.

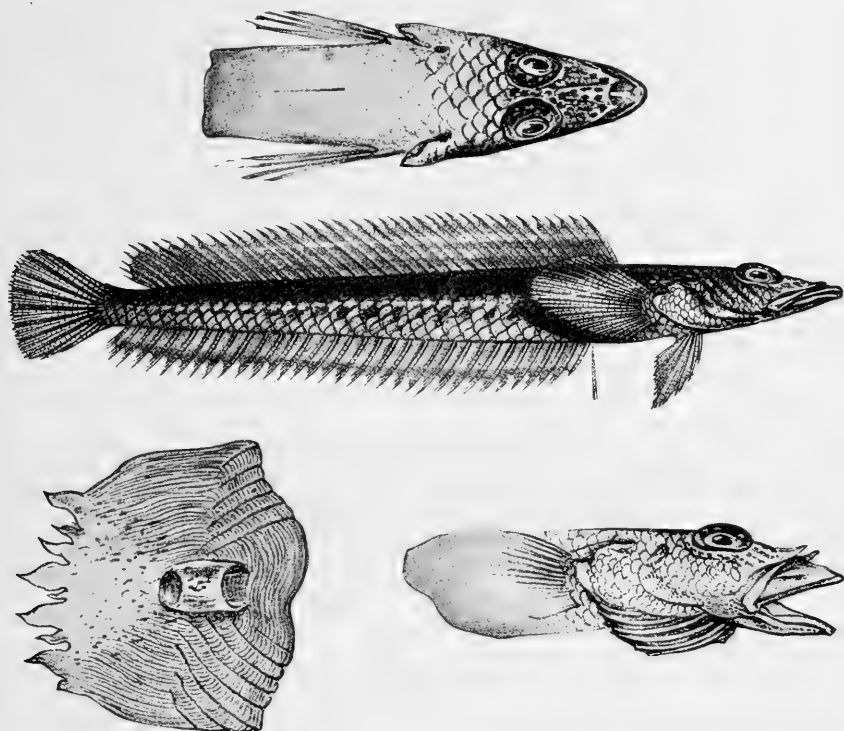


FIG. 2.—HEMEROCETES ACANTHORHYNCHUS. (After Richardson.)

A partial synonymy of the family Ammodytidæ follows:

AMMODYTIDÆ.

Family names.

- Ammodytidæ* BONAPARTE, Cat. Metod Pesci Europei, 1846, pp. 7, 40.
Pantopteres (idiapodes) DUMÉRIL, Ichthyologie Anal., 1856, p. 213.
Ammodytoidæ GILL, Cat. Fishes E. Coast N. Am., 1861, p. 40.
Ammodytids RICHARDSON, Museum Nat. Hist., Zool., 1865, p. 112.
Ammodytæ FITZINGER, Sitzungsber. k. Akad. Wissensch. (Wien), LXVII, 1. Abth., 1873, p. 43.
Ammodytidæ MOREAU, Hist. Nat. Poissons France, III, 1881, p. 215.
Ammodytidæ SMITT, Hist. Scand. Fishes, 1895, pp. 462, 557, 567.
Ammodytidæ WOODWARD, Cat. Fossil Fish B. M., IV, 1901, p. 354.
Ammodytidæ JORDAN, Proc. U. S. Nat. Mus., XXVI, 1903, p. 693.
Ammodytidæ BOULENGER, Ann. Mag. Nat. Hist. (7), XIII, 1904, p. 175.

Subfamily names.

- Ammodytinæ* BONAPARTE, Nuovi Annali delle Sc. Nat., II, 1838, p. 133; IV, 1840 p. 276.
Ammodytiformes BLEEKER, Enum. Sp. Piscium Archipel. Indico, 1859, p. xxv.
Ammodytina GÜNTHER, Cat. Fishes B. M., IV, 1862, p. 384.

As the illustrations of *Heimerocetes* are published in a work to be found in very few libraries, figures representing the entire fish, the head from above and laterally (with mouth opened to show jaws), and a scale are reproduced. The originals were published in the "Ichthyology of the Voyage of H. M. S. *Erebus* and *Terror*," etc., by Sir John Richardson, 1844-1848, on plate 54.

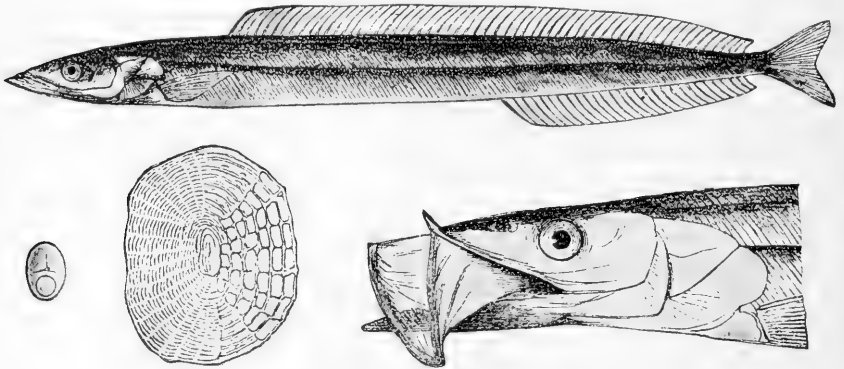


FIG. 3.—*AMMODYTES TOBIANUS*. (After Benecke.)

The illustrations of the typical Ammodytids are derived from the excellent figures in Benecke's *Fische, Fischerie und Fischzucht in Ost- und Westpreussen* (p. 100, fig. 80, and p. 101, fig. 81), reproduced also in Smitt's *Scandinavian Fishes* (pp. 570, 574). That of *Embolichthys* was originally published in the Proceedings of the United States National

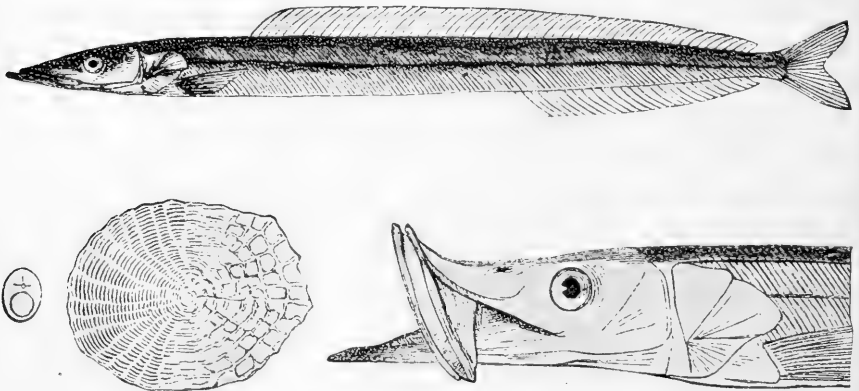


FIG. 4.—*HYPEROPLUS LANCEOLATUS*. (After Benecke.)

Museum for 1902 (XXV, p. 334), and reproduced in the Proceedings for 1903 (XXVI, p. 693).

The figures of the typical Ammodytids are added to show how similar they are to *Embolichthys* in form, the development of the jaws, characteristic opercular apparatus, and form and proportions of the fins. In all these respects they appear to contrast with the Cobitop-

sids. A reexamination of the questions involved and especially comparison of the anatomical peculiarities of the Ammodytids and the Hemerocœtids are greatly to be desired. Lack of material prevents the writer from entering upon the task.

The figures of the opened mouth show how distinct the northern Ammodytids are—enough so to warrant recognition of the genera *Ammodytes* and *Hyperoplus*, suggested by Günther and admitted by Gill, as well as by Jordan and Evermann. In the typical *Ammodytes* (*tobianus*) the intermaxillaries are protrusile and the supramaxillaries have peculiar dentiform tubercles connected with the vomer; in *Hyperoplus* (*lanceolatus*) the intermaxillaries are not protrusile, at least in the old, and the vomer is armed with a pair of teeth which have been confounded with the supramaxillary tubercles of *Ammodytes*.

As to *Cobitopsis*, I am unable to appreciate the reasons for the reference of the genus to the "Percesoces." The ventral fins are said to have "only about 6 *divided rays*," and it has short "dorsal and anal fins similar and directly opposed, close to the caudal." On the evidence presented I should have referred the genus to the neighborhood at least of the Esocidæ and Poeciliidæ, if not with one of them—the latter if the jaws really do agree. The distinctive characters of the *Cobitopsidæ* are not evident. There may have been unrepresented reasons, however, which led the very distinguished and able ichthyologists of London to the conceptions they have published. The jaws are not represented in the figure of *Cobitopsis acutus* published in the Catalogue of the Fossil Fishes in the British Museum (IV, p. 355).



THE DRAGONFLIES (ODONATA) OF BURMA AND LOWER SIAM.—I. SUBFAMILY CALOPTERYGINÆ.

By EDWARD BRUCE WILLIAMSON.

Of Bluffton, Indiana.

This series of papers is based on three collections: First, a collection belonging to the United States National Museum made by Dr. W. L. Abbott in Lower Siam; second, a collection owned by the Philadelphia Academy of Natural Sciences made by Mrs. A. V. B. Crumb, presumably in the vicinity of Toungu, Burma; and third, a collection made for me by Mr. R. A. Earnshaw in the Karenni and Toungu districts, Burma. Mr. Earnshaw writes that his specimens were mostly taken along mountain streams and at elevations of from 4,000 to 6,000 feet. In the future I hope to receive from Mr. Earnshaw some notes on seasonal distribution of the dragonflies of these districts for publication in this series of papers.

The first two collections mentioned above I have received for study at the suggestion of Dr. Philip P. Calvert, to whom the Siamese collection had already been loaned, this loan being transferred to myself. I am indebted in the preparation of this paper to Prof. James G. Needham, in whose laboratory and under whose direction the wing photographs, reproduced in this article, were made from material taken from the collections before me.

The purpose of this study is twofold: First, to identify and record the species in the three collections, offering such notes as may suggest themselves and describing any forms that appear to be unknown. The bibliographical references to be found in Kirby's Catalogue^a and in more recent papers, especially Krüger's Odonaten von Sumatra^b and papers by Laidlaw on dragonflies of the Malay Peninsula,^c make

^aA Synonymic Catalogue of Neuroptera Odonata, or Dragonflies. With an Appendix of Fossil Species. By W. F. Kirby. London, Gurney & Jackson. 1890.

^bStett. Ent. Zeit., LIX, 1898, pp. 64-139, 267-331; LX, 1899, pp. 321-338; LXIII, 1902, pp. 58-193; LXIV, 1903, pp. 248, 292.

^cOn a collection of dragonflies made by the Skeat expedition in the Malay Peninsula in 1899-1900, by F. F. Laidlaw. Proc. Zool. Soc. London, 1902, I, pp. 63-92, pls. v, vi; II, pp. 381-389; Fasciculi Malayenses, Zoology I, 1903, pp. 189-200.

other than occasional references in this matter unnecessary. Second, to incorporate in the papers keys and, if necessary, other descriptive matter sufficient to enable anyone interested to determine for himself the species known to occur in the regions under consideration. However, but comparatively few localities have been visited by collectors; consequently in these papers great incompleteness, when compared with the list of species eventually to be found, must be expected. "May its incompleteness be soon shown by a multitude of new discoveries."

De Selys in 1891^a recorded 88 odonates from Burma, based on collections made by Leonardo Fea, and numbering more than 750 specimens. The localities visited by Fea are as follows: Teinzo, a village about 24° 30' north latitude, northeast of Bhamo, on the Moolay River, a tributary of the Irawadi; Bhamo and Shwegoo on the Irawadi; Mandalay on the Irawadi, 22° north latitude; Rangoon and Palon, between 16° and 18° north latitude, on the Irawadi; Toungu, 19° north latitude, on the Sittang River; Leitò, Cobapò, Puepoli, Meteleo, Iado, Taò, and Chialà, villages in the mountainous regions between the Sittang and Salwin valleys; Moulmein, Kokarit, Meetan, Thagatà, and Malewoon, towns between 10° and 17° north latitude. As mentioned elsewhere, the material studied by myself from Burma comes only from the neighborhood of Toungu. Doctor Abbott's collecting in Siam was all done in the province of Trong, Lower Siam.

This paper deals with the subfamily Calopteryginae. De Selys in 1891 listed 11 species from Burma. Twenty-one species are now known from Burma and Siam. The collections before me include 17 of these. This subfamily includes many of the most beautiful dragonflies of the world, iridescent and metallic effects glowing on wings and bodies with the brilliancy of gems. In size they vary from pigmies to giants, but all are delicate insects and often the body is extremely slender. Undoubtedly the study of their habits should attract those to whom the beauties of nature are a continual delight, revealing much of interest and value. In collections of dragonflies from Burma and Siam, as in all collections almost without exception regardless of locality, males are much more numerous than females. In the genera *Euphæa* and *Dysphæa*, for example, De Selys has commented on the great rarity of females, attributing this to the fact that they have not attracted collectors as have the brighter males. Mr. Laidlaw^b thinks "that this scarcity in collections is not due to their being overlooked by collectors. I can safely say that I never saw a female of this species (*Dysphæa limbata*) or of *Euphæa impar*, while the males were at times abundant." But Mr. Laidlaw's argument in no wise invalidates

^aOdonates de Birmanie, Ann. del Museo Civico di Storia Naturale di Genova, Serie 2a X (XXX), 1891, pp. 433-518.

^bProc. Zool. Soc. Lond., Feb. 4, 1902, p. 88.

De Selys's statement, since it is not shown that he, Laidlaw himself, did not overlook the females. His failure to discover them may have been because of one or both of two possible reasons: They may conceal themselves in the vegetation near the haunts of the males, appearing on the wing rarely and then at hours of the day not suspicioned by the dragonfly collector; or they may habitually frequent retreats in the jungles far from the localities where the males are conspicuous with brilliant wings to attract the collector to the most favorable hunting grounds. There may be other reasons, too, why the females are less known in collections, but the above remarks will indicate that original observations are possible and desirable. In the present paper only imagoes are discussed. Nothing could be more desirable in this connection than a collection of nymphs sufficient to at least allow of the definition of generic characters in immature stages.

KEY TO THE ORIENTAL GENERA OF THE SUBFAMILY CALOPTERYGINÆ (IMAGOES).^a

ORDER ODONATA (Neuroptera Odonata, Paraneuroptera).

a. Fore and hind wings similar in venational structure; quadrangle present; wing membranule wanting; supplements (veins across wing membrane opposed to principal veins) wanting. Head wide, eyes separated. Males with 2 inferior abdominal appendages; females with genital valves. . . . SUBORDER ZYGOPTERA

b. M_3 separating from M_{1+2} nearer the nodus than the arculus.

FAMILY AGRIONIDÆ

bb. M_3 separating from M_{1+2} nearer the arculus than the nodus, or at not more than half the distance from arculus to nodus. FAMILY CALOPTERYGIDÆ

c. Antenodals 2 SUBFAMILY LESTINIDÆ

cc. Antenodals 4 or more SUBFAMILY CALOPTERYGINÆ

d. M_{1-3} and M_4 rising from the middle or near the middle of the arculus, not together from its extreme anterior end.

e. Antenodals of first series not coinciding with those of second series beyond the level of the arculus; M_{1+2} and M_3 forming a symmetrical fork, or M_{1+2} continuing the direction of M_{1-3} ; wings petioled at least one-half way to the arculus; subquadrangle bent at the arculus.

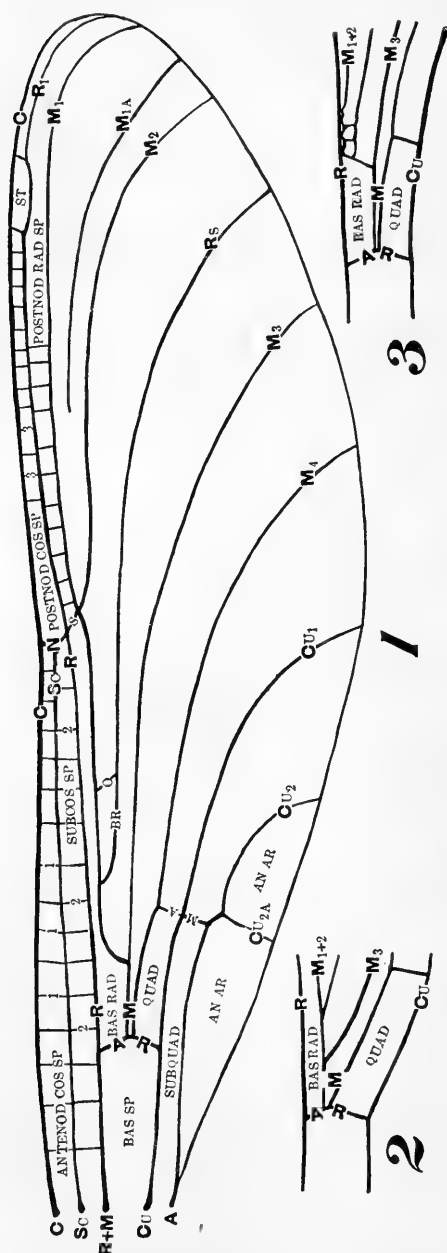
f. Antenodals of second series wanting beyond the level of the arculus; normally 4 antenodals continuous in the first and second series; wings petioled and narrowed nearly to the level of the arculus and half way to the level of the nodus; distance from base of front wing to nodus less than $\frac{1}{3}$ wing length; M_2 arising beyond the nodus at about the fourth postnodal of the second series; quadrangle about $\frac{1}{3}$ as long as basal space and with 2 cross veins; M_{1a} parallel to M_1 ; stigma ovate *Deradatta*

ff. Antenodals of second series present beyond the arculus; wings less petioled and the nodus not so retracted.

g. Second antenodal over arculus; M_{1-3} and M_4 arising from a single point; quadrangle wider proximally. *Micromerus*

^aTwo genera, *Caliphya* and *Philoganga*, known to me only from descriptions, are omitted. Neither genus is known from Burma or Siam.

A, anal vein (postcostal vein); *antnod cos sp*, antenodal costal space (antecubital costal space); *an ar*, anal area (postcostal space); *AR*, arculus; *bas rad*, basal radial space; *bas sp*, basal space (basilar space, upper basal cell or median space); *br*, bridge; *C*, costa (costal vein);



FIGS. 1-3.—DIAGRAMMATIC WING OF A DRAGONFLY OF THE SUBFAMILY CALOPTERYGINE SHOWING THE NOMENCLATURE OF THE VENATION.

Cu, cubitus (submedian vein); *Cu₁*, first branch of *Cu* (first sector of the triangle); *Cu₂*, second branch of *Cu* (second sector of the triangle); *Cu_{2a}*, branch of *Cu₂* (inferior branch of second sector of the triangle); *M*, media (upper and lower sectors of the arculus); *M₁*, first branch of *M* (apical part of principal sector—extending from subnodus, *S*, to apex of wing); *M_{1a}*, long sector between *M₁* and *M₂* (ultranodal or postnodal sector); *M₂*, second branch of *M* (nodal sector); *M₁₊₂*,^b trunk from which arise the first and second branches of *M* (basal part of principal sector—extending from its origin to subnodus, *S*); *M₃*, third branch of *M* (median sector); *M₄*, fourth branch of *M* (short sector); *ma*, medioanal link; *N*, nodus (cross vein at end of *Sc*, between *C* and *R*); *O*, oblique vein; *postnod cos sp*, postnodal costal space (postcubital costal space); *postnod rad sp*, postnodal radial space; *quad*, quadrangle (quadrilateral); *R*, radius; *R+M*, radius+media (median vein); *R₁*, first branch of *R*; *Rs*, radial sector (subnodal sector); *S*, subnodus; *Sc*, subcosta (subcostal vein); *St*, stigma (pterostigma); *subcos sp*, subcostal space; *subquad*, subquadrangle (median space or lower basal cell); 1, antenodal of first series (antecubital of first series); 2, antenodal of second series (antecubital of second series or subcostal cross vein); 3, postnodal (postcubital); in fig. 1 the antenodals number about 15 and the postnodals about 17. In fig. 2 the basal radial space is open—that is, *M₁₊₂* beyond the arculus does not approach *R*; in fig. 1 the basal radial space is partly closed—that is, *M₁₊₂* beyond the arculus approaches *R*; and in fig. 3 the basal radial space is closed—that is, *M₁₊₂* beyond the arculus reunites with *R*. In figs. 1 and 3, *M₃* continues the direction of *M₁₋₃*; in fig. 2, *M₁₊₂* and *M₃* form a symmetrical fork, or *M₁₊₂* continues the direction of *M₁₋₃*.

^aThe question arose whether this vein is a branch of 1 or *Cu₂*. The opinion expressed above is that of Professor Needham, to whom I am also indebted for other suggestions in terminology.

^bNot labeled on fig. 1.

^c*M₁₋₃* is the upper sector of the arculus. It is the trunk from which arise the first, second, and third branches of *M*, and extends from *AR* to the origin of *M₁₊₂*.

- gg. Third antenodal over arculus;^a M_{1-3} and M_4 separate at their origin; quadrangle uniform in width.
- h. Venation simple; secondary sectors reduced in number and length, the longest on either side of M_{1a} not rising before the inner side of the stigma; quadrangle with 1 cross vein *Libellago*
- hh. Venation more complex, the longest secondary sector on anterior side, and usually on posterior side of M_{1a} rising before the inner side of the stigma; more than one cross vein in the quadrangle..... *Rhinocypha*
- ëe. Antenodals uniform and undifferentiated (usually more than 20), those of first series largely coinciding with those of second series; M_3 continuing the direction of M_{1-3} ; wings slightly or not at all petioled; subquadrangle straight or slightly bent at the arculus.
- f. Subquadrangle slightly bent at arculus; basal space at least $1\frac{1}{2}$ times as long as quadrangle; quadrangle with less than 4 cross veins.
- g. Cu_{2a} not present; nodus before middle of wing; wings petioled for a short distance; postnodals more numerous than antenodals.
- h. Cross veins reduced, quadrangle and basal radial space free, and subquadrangle with a single cross vein; basal space more than twice as long as quadrangle.
- i. Basal radial space closed..... *Bayadera*
- ii. Basal radial space partly closed..... *Anisopleura*
- hh. Quadrangle and basal radial space crossed and subquadrangle with 2 or more cross veins; basal space about twice as long as the quadrangle *Euphaea*
- gg. Cu_{2a} present; nodus at middle of wing; wings not petioled; antenodals more numerous than postnodals *Dysphæa*
- ff. Subquadrangle straight; basal space shorter than or only very slightly longer than quadrangle; basal radial space with cross veins; quadrangle with 4 or more cross veins.
- g. Arculus not angled, oblique; M_{1-3} and M_4 arising from a single point near posterior end of arculus; quadrangle widest at its distal end; Cu_2 curved strongly posteriorly, Cu_{2a} wanting; M_2 , M_3 , Cu_1 , and Cu_2 forked; basal space free; basal radial space closed; stigma wanting..... *Vestalis*
- gg. Arculus distinctly angled; M_{1-3} and M_4 separate at their origin; Cu_{2a} present.
- h. Basal space free; stigma present.
- i. Basal space and quadrangle about equal in length, the quadrangle usually with 4 or 5 cross veins..... *Mnais*
- ii. Quadrangle narrow, about $1\frac{1}{2}$ times as long as basal space, with 10 or more cross veins *Psolodesmus*
- hh. Basal space crossed.
- i. True stigma present; radial sector in hind wing not strongly waved.
- j. Neuration complex; anal area wide, and the hind margin of the wing along this area broadly convex; in the hind wing the area between Cu_1 and Cu_2 at their origin is reticulate.
- Archineura* (from Kirby's figure)^b

^a The middle one of the 3 antenodals in *Rhinocypha* and *Libellago* is not present in the wing of *Micromerus*, and is not coinciding in the first and second series, unless accidentally.

^b McLachlan has described both sexes of *Archineura incarnata* from western China, and he questions the correctness of Mr. Kirby's type locality, Fuchau, "although it may have been brought to that port from the interior."

- ij. Anal area simpler, narrower, the hind margin of the wing near the wing base straight or slightly concave; one row of cells between Cu_1 and Cu_2 at their origin.
 - k. Nodus at a point less than $\frac{1}{2}$ the distance from wing base to stigma *Echo*.^a
 - kk. Nodus placed beyond the point midway between wing base and stigma *Climacobasis*.^a
 - ii. Stigma wanting or only a false stigma present; radial sector in hind wing strongly waved. (Subdivided by Förster as follows:)
 - j. Four wings of male opaque.
 - k. Cells of basal space for the most part divided *Matrona*
 - kk. Only one or two cells of basal space divided *Matronoides*
 - ij. Front wings of male hyaline *Neurobasis*

1. DEVADATTA ARGYOÏDES (De Selys).

I have seen a single female, collected by Doctor Abbott, Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February,

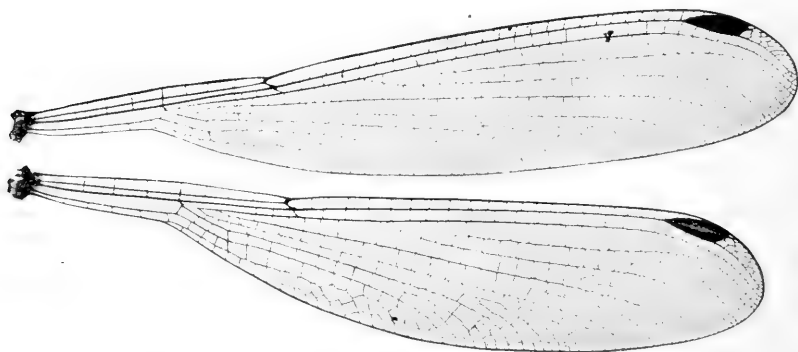
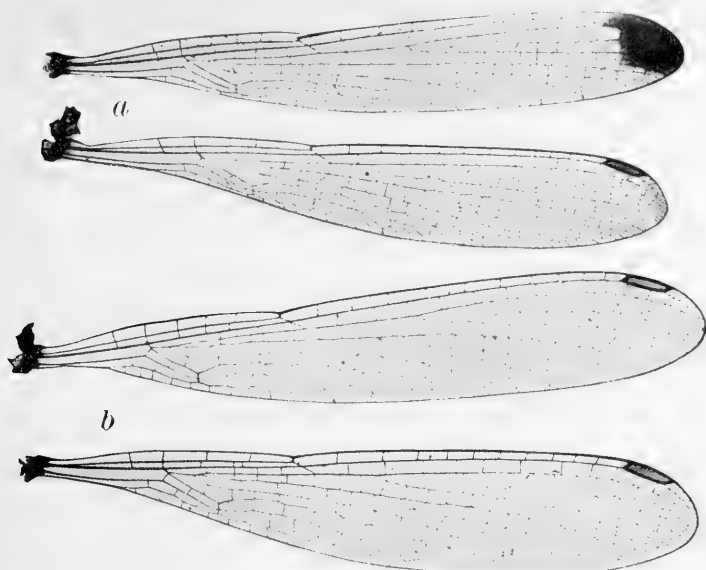


FIG. 4.—WINGS OF FEMALE DEVADATTA ARGYOÏDES FROM SIAM.

1899. This specimen has the abdomen 34 mm. in length and the hind wing 31. The species has been recorded from the Malay Peninsula and Borneo.

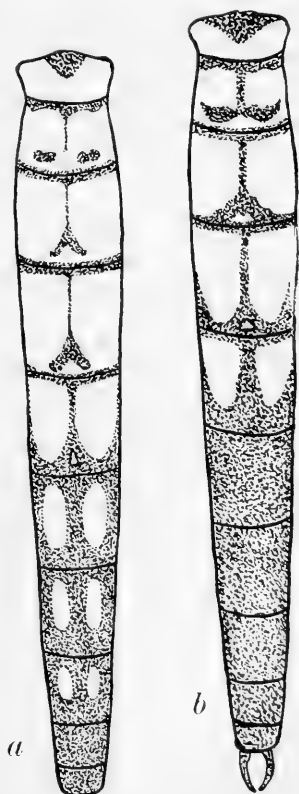
^a*Echo* is known to me only from descriptions and figures, but such differences between it and *Climacobasis* appear to exist in the anal region and in the stigmas of the males that, in so far as the two names have been published, their separation seems to me desirable, at least till a more critical study can be made.

FIG. 5.—WINGS OF MICROMERUS LINEATUS FROM SIAM. *a*, MALE; *b*, FEMALE.

2. MICROMERUS LINEATUS (Burmeister).

Material studied: Trong, Lower Siam, collection U.S.N.M., 25 males, 34 females. Burma, collection P. A. N. S., 4 males; collection Williamson, 2 males.

Abdomen with the pale areas more extensive in younger individuals. De Selys has questioned the specific distinctness of *M. obscurus* Kirby from Hassan Abdal. The dull coloration of the body and basal coloration of the wings in Kirby's specimen certainly indicate a teneral condition, but in the material examined by myself, though a number are very teneral, in all the color pattern of the abdomen indicated in my figures is plainly discernible. So far as I am able to judge from Kirby's figure and description, *obscurus* seems distinct from *lineatus*, though it may not be different from some of the species with abdomens largely pale in color. *M. lineatus* has hitherto been recorded from Penang, Java, Burma, Ceylon, and India.

FIG. 6.—COLOR PATTERN OF THE DORSUM OF ABDOMEN OF MICROMERUS LINEATUS FROM SIAM. *a*, TENERAL MALE; *b*, MATURE MALE.

3. MICROMERUS AURANTIACUS De Selys.

The collection made by Doctor Abbott contains a single male from Khow Sai Dow Mountain, Trong, Lower Siam, January–February, 1899. Abdomen, 13.5 mm. in length; hind wing, 16.5; opaque spot on front wing, 3.5 in length. Abdomen basally yellow, passing into red apically. Probably the predominance of one of these colors over the other is entirely a matter of age. *M. annandali* Laidlaw, described from a single male from Mabek, Hulu Jalor, seems scarcely distinct from *aurantiacus* originally described from Malacca.

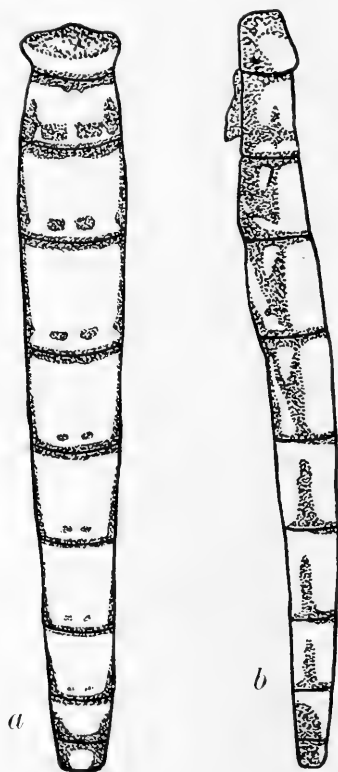


FIG. 7.—COLOR PATTERN OF THE ABDOMEN OF A MALE MICROMERUS AURANTIACUS FROM SIAM.
a, DORSAL VIEW; b, LATERAL VIEW.

Since the publication of Kirby's catalogue four species of *Micromerus* have been described as new: *M. martinæ* Karsch,^a from Sumatra; *M. signatus* Krüger,^b from Java and Penang; *M. affinis* Laidlaw,^c from Kwala Aring; *M. annandali* Laidlaw,^d from Mabek, Hulu Jalor. Nineteen specific names have been proposed in this genus, and of these it is remarkable that only one is certainly a synonym.

^a Ent. Nach., XVII, 1891, p. 243.

^b Stett. Ent. Zeit., 1898, p. 86.

^c Proc. Zool. Soc. Lond., Feb. 4, 1902, p. 90.

^d Fasciculi Malayenses, Zoology, I, Oct., 1903, p. 197.

4. LIBELLAGO VITTATA De Selys.

“Bhamo en juin et juillet (Fea).” No specimens of this species are represented in collections before me.

RHINOCYPHA Rambur.

Dorsal mesothoracic triangular area long, reaching the antealar sinus. Male: wings expanded, anal area beyond the level of the medio-anal link at its widest part at least 3 times as wide as at its narrowest part; Cu_2 not zigzagged before half its length; hind wings with 3 rows of vitreous spots. *Fenestrella* group.

Male. Middle series of vitreous spots on hind wing consisting of 2 spots, the posterior one 7-9 cells wide; apical spot about 10 cells wide. *cuneata*, *adamantina*

Male. Middle series consisting of 3 spots (often a fourth between the middle and posterior one), the 2 posterior ones homologous with the posterior spot of *cuneata*; apical spot 8 cells or less wide.

Apical spot 4-6 cells wide, entirely under stigma; stigma red, surrounded with black, darker in old individuals. *fenestrella*

Apical spots 8 cells wide, basally not under the stigma; stigma black, obscure yellowish in the middle. *quadrinaculata* and *spuria*

Dorsal mesothoracic triangular area short. Male: wings less expanded, anal area less widened; Cu_2 zigzagged for more than half its length.

Male. Apical third of the hind wings dark colored. *biforata*

Male. Apical dark color on hind wings beginning at the nodus. *ignipennis*

Male. Apical dark color on hind wings beginning at the level of the medio-anal link. *iridea*

Since the publication of Kirby's catalogue the following species have been described:

R. turconii De Selys,^a “Patrie: Panay pay (Ile de Zebu).” Described as related to *heterostigma* and *anisoptera*.

R. iridea De Selys.^b Burma: “Leitò en mai; puepoli en juin (Fea).” Described as related to *fenestrata*.

R. stygia Förster,^c “Patrie: Le mont Kina, Balu, au nord de l'île de Borneo.” In wing coloration this species is described as related to *immaculata*.

R. pagenstecheri Förster,^d “Heimat: die Insel Lombok.” Related to *terminata*.

R. pagenstecheri subrasse *sumbana* Förster,^e “Heimat: Patadalu, Sumba-(Sandelholz-)Insel.”

R. apicalis Krüger.^f Described as “*Rhinocyppha bisignata* Hagen! *apicalis* n. sp.” “Heimath: Sumatra, Sinabong (Dohrn).”

^aAnales de la Soc. Esp. de Nat. Hist., XX, 1891, p. 215.

^bAnn. del Museo Civico di Storia Nat. di Genova, Serie 2^a, X (XXX), 1891, p. 492.

^cAnn. Soc. Ent. Belg., XLI, 1897, p. 210.

^dEnt. Nachr., XXIII, 1897, p. 333.

^eIdem, p. 335.

^fStett. Ent. Zeit., 1898, p. 79.

R. selysi Krüger,^a "Heimath: Nur Sumatra, Soekaranda (Dohrn)." "Diese neue art gehört zur Gruppe *heterostigma*."

R. karschi Krüger,^b "Heimath: Nur Sumatra, Soekaranda (Dohrn)." "Diese neue art bildet eine neue Gruppe bei *Rhinocypha* zwischen *heterostigma* und *tineta*."

R. braueri Krüger,^c "Heimath: Nur Sumba (Grelak)." Described as related to *unimaculata* and *stygia*.

R. hayeni Krüger,^d "Heimath: Nur Jolo (Standinger)." Described as belonging to the group *tineta*.

R. whiteheadi Kirby,^e Hainan. Allied to *perforata*.

R. inas Laidlaw,^f Gunong Inas. "Closely allied to *perforata*." "The marks of the hind wing resemble most closely those of *R. whiteheadi* Kirby."

R. adamantina Förster,^g "Heimath ebenfalls Sikkim, ohne genaueren Fundort." Described as most closely related to *quadrinaculata*.

R. aurulenta Förster,^h "Heimath: Die Südmolukken-Insel Buru der sie endemisch zu sein scheint." "*R. aurulenta* gehört zur *terminata*-Gruppe, die sie mit der *semitineta* verknüpft."

No less than 49 specific names have been proposed in this genus. The tendency recently seems to be to regard many of these as local races, if distinct at all.ⁱ *R. inas* and *whiteheadi* seem identical with *apicalis*. I can not distinguish *cuneata* and *adamantina* nor *quadrinaculata* and *spuria* so far as descriptions go.

Speaking of the *fenestrella* group, Förster says:

Rh. quadrinaculata, *adamantina* von Nord Indien, *spuria* von den Khasia Hills, *cuneata* von Thibet und *fenestrella* von Malakka sind Rassen des *fenestrella*-Typus und gehören zu den brillantesten Insekten der Erde.

To one at all familiar with North American fresh-water fishes, these dragonflies, with gorgeous males and sober females, diminutive members of a family containing many giants, can not but suggest the darters (*Etheostominae*) of whom Professor Forbes has written:

Although diminished in size * * * they have developed * * * a vigor of life and a glow of color almost unknown among the easier dwellers of the lower lands. * * * Notwithstanding their trivial size, they do not seem to be dwarfed so much as concentrated fishes.

^aStett. Ent. Zeit., 1898, p. 81.

^bIdem, p. 83.

^cIdem, p. 133.

^dIdem, p. 135.

^eAnn. and Mag. Nat. Hist., 7th ser., V, June, 1900, p. 536, pl. XII, fig. 4.

^fProc. Zool. Soc. Lond., Feb., 1902, p. 88, pl. VI, fig. 6.

^gAnn. Mus. Nat. Hungarici, 1903, p. 547.

^hIdem, p. 547.

ⁱSelys, Ann. Soc. Esp., XX, 1891, pp. 213-215, and Förster, Ann. Mus. Nat. Hungarici, 1903, pp. 546, 547.

The dense chalky white pruinescence of the under surface of the tibia of adult males has evidently to do with sex attraction. Laidlaw^a records the following note for *fenestrella*:

Dances in the air before the female, displaying white surface of tibiae.

In the North American *Calopteryx maculata* there is a definite ventral apical abdominal spot which is shining white in living, fully adult males. This area is displayed by a male at rest by curving the abdomen so that the apex is brought upward and forward, the hind wings meanwhile being fluttered rapidly while the front wings are held motionless. The pruinose white spot thus turned dorsally becomes conspicuous, especially as held between the brilliant black fluttering wings. The extent of pruinescence is often a matter of age, old males of some species being almost entirely pruinose, but the first appearance of this is usually on the dorsum of the thorax and the dorsum of the last abdominal segments, and in many species these areas alone become pruinose. In the *Agrioninae*, where pruinescence is rarer than in the subfamily under consideration, these parts, i. e., dorsum of thorax and last abdominal segments, are in the males usually the most conspicuously colored portions of the insects, while the abdomen of the females of the same species may not be strikingly colored. In species of *Eupallagma*, for example, the thoracic markings are very similar in the two sexes, while the abdomen is conspicuously different. It may be noted that the male of these species captures the female by seizing her thorax with his legs, and so holds her till he has fixed his abdominal appendages on her prothorax. The male of *Argia putrida* soon after emergence has the dorsum of the abdomen black. Its congeners in Indiana have the apical segments brightly colored, and when *putrida* reaches sexual maturity the apical segments have become pruinose. The prothorax of many of these species is brightly colored; and the second abdominal segment of the male, which bears the accessory genitalia, has a striking and conspicuous color pattern, serving possibly as a guide to the female in bringing her vulva in contact with the male genitalia. The auricles of the second abdominal segment of males in other subfamilies may serve a similar purpose. In some of the Calopterygidae the basal abdominal segments early assume a decided pruinescence. The pruinose spot on the vertex of the adult male of *Climacobasis modesta* is conspicuous, and an exactly similar spot appears in other species when the pruinescence has come to largely occupy the entire body. In the *Libellulinae* the male and female of many species are nearly identical in color at the time of emergence, while with age the male becomes largely or entirely pale bluish or white pruinose, thus distinguishing the two sexes at the time of their maturity.

^a Fasciculi Malayenses, p. 169.

5. RHINOCYPHA QUADRIMACULATA De Selys.

Material studied: Burma, collection Williamson, 1 male.

This single specimen, which I was disposed to regard as belonging to an undescribed race, has been examined by Professor Förster who writes that it agrees perfectly with specimens from Sikkim in his collection, pronounced *quadrимaculata* by De Selys. This specimen is smaller, rather than larger, than *fenestrella*. It may be described as follows: Abdomen 19 mm.; hind wing 21. Head in front clear shining black, eyes chestnut brown; head above shining black; lateral ocelli orange, a closely adjacent spot external to each ocellus, same size as the ocellus, yellow, and behind these spots, at either end of the posterior ridge of the occiput, is an orange spot; these two last-described spots and the anterior ocellus are at the three angles of an equilateral triangle; tip of second joint of antennæ dull yellow. Prothorax black,

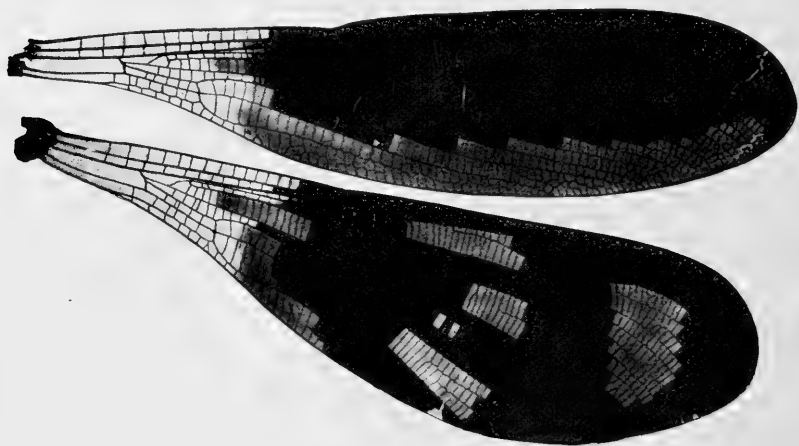


FIG. 8.—WINGS OF MALE RHINOCYPHA QUADRIMACULATA FROM BURMA.

posterior lobe with a narrow, sharply defined, longitudinal median yellow stripe; thorax black, median triangular area reaching the antealar sinus, pink in color, narrower than in *fenestrella*, the sides slightly concave. Lateral sclerites with reduced yellow stripes below; these stripes together give the impression of a nearly continuous longitudinal line parallel to the coxæ and extending posteriorly to the first abdominal segment; the stripe on the metepisternum is placed just before the second lateral suture and extends from the metinfraepisternum two-thirds of the distance to the base of the hind wing; humeral suture with the merest yellow streak above. Legs black, femora of the two last pair lighter beneath apically; tibiæ of two last pair with heavy chalky-white pruinescence beneath; pectus black. Wing markings as figured; in the hind wing 3 rows of vitreous spots;

the first row consisting of 2 spots, the anterior spot one-cell wide, lying between R_s and M_3 , the posterior reaching from M_4 to the hind margin of the wing. The second row consists of 3 distinct spots, the anterior lies between M_1 and M_2 , the middle spot between R_s and M_3 , and the posterior between M_4 and Cu_1 ; an imperfect spot is present between the middle and posterior spots; undoubtedly in some individuals this disappears and in others a well-marked spot is present, variable as in the case of *fenestrella*. The third and apical row consists of a single large spot lying between M_{1a} and the first secondary sector anterior to M_3 . Stigma of front wings black, median portion subapically yellowish brown, not sharply defined; of hind wings dorsally black, with nearly half subapically pale yellowish brown, ventrally with the pale area more sharply defined, pale yellow in color. Abdomen black.

Distinguished from *fenestrella* by having the anterior of the median row of spots decidedly nearer the nodus (beginning before M_{1a}), with the result that the spot is narrower, and its anterior edge is more bounded by M_1 , while in *fenestrella* the basal anterior border of this spot is more or less formed by M_{1a} . In *fenestrella*, moreover, the three spots of the median row are about equal in length, while in *quadrимaculata* the middle spot is abbreviated basally about half the length of the other two spots. The large apical spot is, in *quadrимaculata*, not entirely under the stigma as in *fenestrella*, and it is decidedly larger, although this last point will be found undoubtedly subject to great variation since the anterior and posterior borders of this spot in the specimen before me are formed by secondary sectors in both cases; for this apical spot to increase or decrease one cell's width either anteriorly or posteriorly should not be unexpected. Differences in the stigma also exist between *fenestrella* and *quadrимaculata* as pointed out in the key above. In *quadrимaculata* the yellow stripe on the metepimeron is longer than in *fenestrella* and more continuously parallel to the latero-ventral metathoracic carina. *Quadrимaculata* has hitherto been described as larger than *fenestrella*; the now known range in size is abdomen 19–23 mm., hind wing 21–25. I believe *quadrимaculata* is specifically distinct from *fenestrella*, but indistinguishable from *spuria*.

6. RHINOCYPHA FENESTRELLA Rambur.

Material studied: Siam, collection U.S.N.M., Trong, Lower Siam, 13 males, 2 females; Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 6 males, 5 females. Burma,

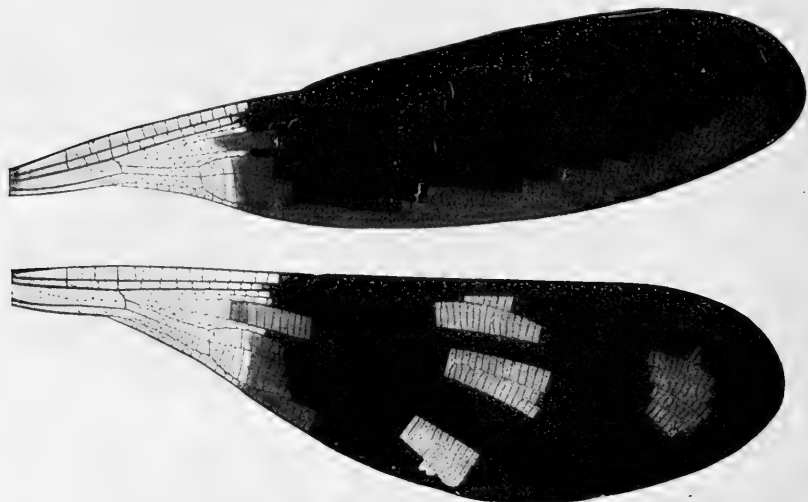


FIG. 9.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM BURMA.

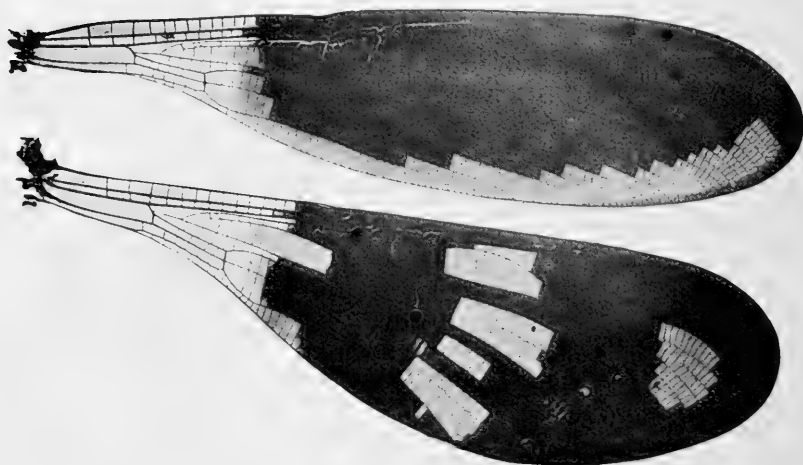


FIG. 10.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM BURMA.

collection P. A. N. S., 9 males; collection Williamson, 19 males, 4 females.

In this species the vitreous area on the front wings of males behind the opaque area occupies from one-fifth to nearly one-half the wing width. In specimens from Burma and Siam one-fifth to one-third is

most usual. The triangular dorsal area of males is red or blue, or both colors in the same individual. This red and blue are very delicate, comparable almost to the reflections of the vitreous areas of the wings.

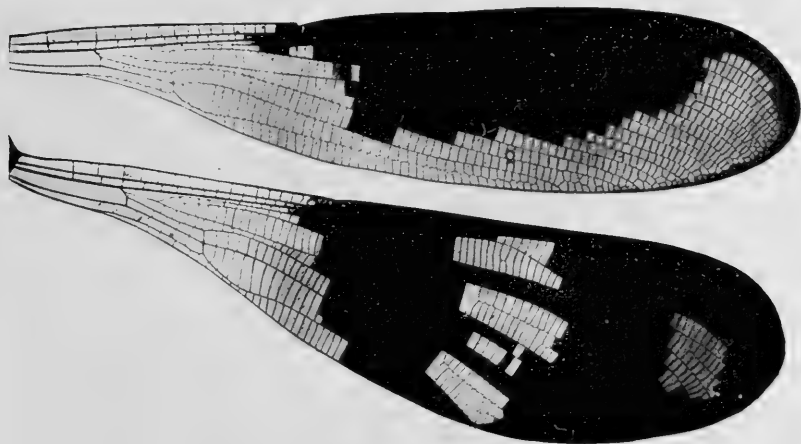


FIG. 11.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM PERAK.

7. RHINOCYPHA BIFORATA De Selys.

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 5

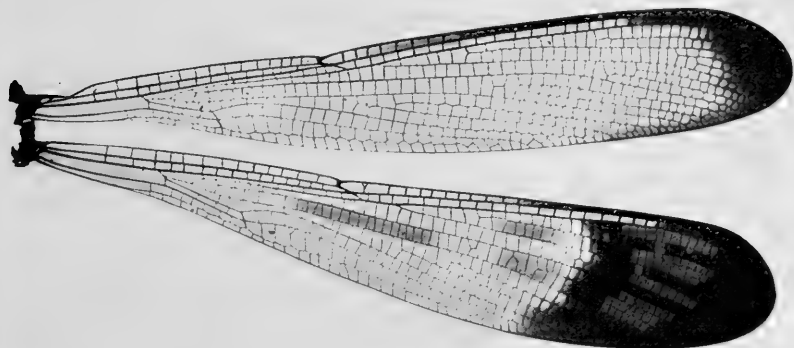


FIG. 12.—WINGS OF MALE RHINOCYPHA BIFORATA FROM SIAM.

males, 2 females. Burma, collection Williamson; a very teneral male seems to belong here.

8. RHINOCYPHA IGNIPENNIS De Selys.

Material studied: Burma, collection Williamson, 1 male.

This single specimen, with the male of *quadrimaculata* described above, was sent to Professor Förster. My opinion was that it represented an undescribed species closely related to *ignipennis*. Profes-

sor Förster writes of this specimen, "Wings not in full color, but perhaps the coloration of the body may indicate a species distinct from the races of *ignipennis*; but this is a very difficult matter to settle." Because of the very scanty material before me I content myself with referring it to *ignipennis* for the present. A description of the single male follows: Abdomen 21 mm.; hind wing 25. Labium yellowish white, black tipped; a large greenish-white spot on either side of labium, between labium and eye; a spot on the outer side of each posterior ocellus and two on the posterior ridge of the occiput, greenish white. The triangle formed by lines connecting these 2 posterior spots and the anterior ocellus has the line between the 2 spots as the longest side; an oblong spot on the rear of the head between the 2 posterior spots. Eyes bronze with purplish reflections above. Rest of head black, shining in front, velvety above.

Prothorax black, anterior lobe with 2 pale bluish spots on either side; middle lobe with 2 larger pale bluish spots on either side; hind lobe with its antero-dorsal surface crescent-shaped and rust red in color. Thorax black above, mid dorsal triangular area short, dark rust-red in color, its base about one-half as long as its sides; on either side of the dorsum is a stripe reduced to an antealar spot above, an ovate spot below, and just below the ovate spot a small round spot, all blue in color. Metepisternum largely blue, this blue variegated below and behind with orange; mesepimeron with a blue stripe just behind the humeral suture, widening below to fuse with the pale color of the metepisternum opposite the metastigma; metepimeron with a large triangular blue spot occupying nearly its entire surface, the blue variegated behind and below with orange. Metasternum black with two lateral longitudinal yellow stripes and apex pale yellowish.

Wings hyaline, apically with the merest trace of brown, which has bronzy reflections; this dark area begins on the front wings between the nodus and stigma and on the hind wings at the nodus. Hind wings with 2 rows of vitreous spots, which are of a pale bluish milk color by transmitted light, and a light iridescent red by reflected light. So slight is the trace of brown on the four wings, as described above, that in this specimen the vitreous spots are the least transparent portions of the wings. This lack of density in the brown is probably due to immaturity, though I detect no other condition in the specimen to indicate this, unless it be the color of the stigma. The vitreous spots are located as follows: first row, consisting of one spot 9 cells long, has its basal end just beyond the nodus and is placed between R_s and M_s , which sectors bound anteriorly and posteriorly the middle spot of the 3 spots of the second row of vitreous spots; anterior spot of second row placed between M_{1a} and M_2 ; and the posterior spot between M_4 and Cu_1 . All four of the spots are similar in size and shape, the middle one of the second row somewhat the largest, all

about 8 to 12 cells long; the second row is placed at about two-fifths the distance from nodus to stigma; stigma with basal half black, apical half white, bounded by black veins. Legs black. Abdomen black; segment 1 with a large blue spot on either side; segments 2-9 each with a lateral basal blue spot, relatively larger anteriorly where it is ovate in shape extended forward on the side of the segment, posteriorly becoming successively smaller and more rounded; segments 2-7 each with a small short pale streak below on the side near the middle of the segment. This specimen differs from *ignipennis* as described by having the brown area on the wings less extensive, in the position of the first vitreous spot, in the color of the stigma, and in body markings; it differs less from *ignipennis* than from any other species known.

9. RHINOCYPHA IRIDEA De Selys.

This species is not represented in the material before me. De Selys has recorded it from Leitò in May and Puepoli in June.

10. ANISOPLEURA FURCATA De Selys.

Described from a single male taken by Fea at Puepoli, in June. My collection from Burma contains a crushed teneral female of a

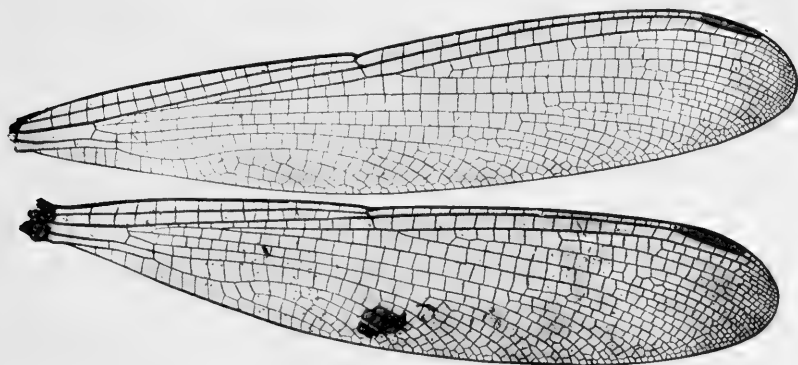


FIG. 13.—WINGS OF FEMALE ANISOPLEURA FURCATA FROM BURMA.

species of *Anisopleura*. This female has the abdomen 30 mm. in length and the hind wing 30. Its condition is such as to make a description impossible.

11. EUPHÆA OCHRACEA De Selys.

Material studied: Burma, collection P. A. N. S., 1 male. Siam, collection U.S.N.M., Trong, Lower Siam, 3 males, 1 female; Khaw Sai Dow Mountain, 1,000 feet, Trong, January-February, 1899, 4 males, 3 females.

This species is distinguished from the next, *masoni*, by having the wings more or less yellow or reddish yellow, and the anal area behind

the medio-anal link, and for the distance of a few cells apically, one cell wide. Teneral males have the slightest tinge of yellow on the wings; females have a tinge of color in the costal and subcostal

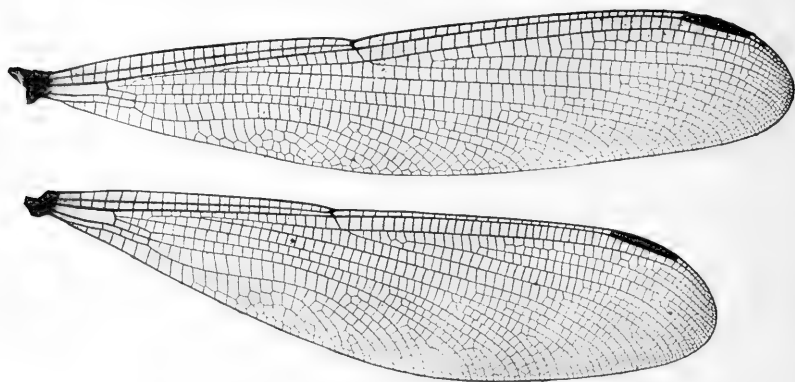


FIG. 14.—WINGS OF MALE *EUPHLEA OCHRACEA* FROM SIAM.

spaces. The single male from Burma has the hind wings slightly wider and more distinctly hyaline (without yellow) at the apex than specimens from Siam. De Selys recorded this species for Puepoli and Leitò (April, May, and June), and Cobapò (September).

12. *EUPHÆA MASONI* De Selys.

In the Burmese collection belonging to the Philadelphia Academy of Natural Sciences is a single male of this species, which sex is at once distinguished from the preceding species by having the wings largely brown or black, and the anal area behind the medio-anal link 2 cells wide. This male has the abdomen 34 mm. in length, and the hind wing 27. A male from Tonkin, in my collection, has these parts respectively 38 and 32 mm. The Burmese specimen has the costal space of the front wings half way to the nodus and the basal space of the hind wings largely hyaline. Mr. Kirby has recorded the species for Upper Burma.

13. *DYSPHÆA LIMBATA* De Selys.

Trong, Lower Siam, 1 male, collection U.S.N.M.

Wings with about the basal half black, the apices black tipped; the opaque on the front wings reaches to the nodus in the costal and subcostal spaces, the area posterior to the subcostal space reaching to within about 3 cells of the nodus; edge of opaque area straight till near the hind border, when it turns basally; postnodal costal space slightly tinged; hind wings opaque to 9 or 10 cells beyond the nodus, continued in the costal space to the wing tip, edge of opaque area straight, turned basally near the hind margin as in the front wings; tips of all four wings, to 1 or 2 cells under the stigma, black; edge of black tip straight, parallel to the edge of the basal opaque areas.

Abdomen 37 mm.; hind wing 31. The species has been recorded from Malacca, Malay Peninsula, Borneo, and Sumatra.

14. *VESTALIS SMARAGDINA* De Selys.

This species has been reported from the Khasia Hills, Burma, and eastern Thibet. In Burma De Selys has recorded it for Cobapò and Meteleò (September and October), Iadò in December. It is about the same size as *amarna*, from which it may be distinguished by having the sides of the thorax posteriorly yellow, the same parts being metallic green in *amarna*. *Smaragdina* is known to me only from descriptions.

15. *VESTALIS AMOËNA* Hagen.

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 4 males; Trong, lower Siam, 2 males, 4 females.

Abdomen, male 46 mm.; female 40; hind wing, male and female 35. One row of cells between Cu_1 and Cu_2 , excepting near their termination at the wing margin. The color of mouth parts and antennae vary greatly, apparently with age and sex, younger individuals and females having the pale areas more extensive. The species occurs also in the Malay Peninsula, Sumatra, Java, and Borneo.

16. *VESTALIS GRACILIS* (Rambur).

Material studied: Burma, collection, P. A. N. S., 1 male; collection Williamson, 2 males, 5 females. Siam, collection U. S. N. M., Trong, Lower Siam, 1 male, 1 female.

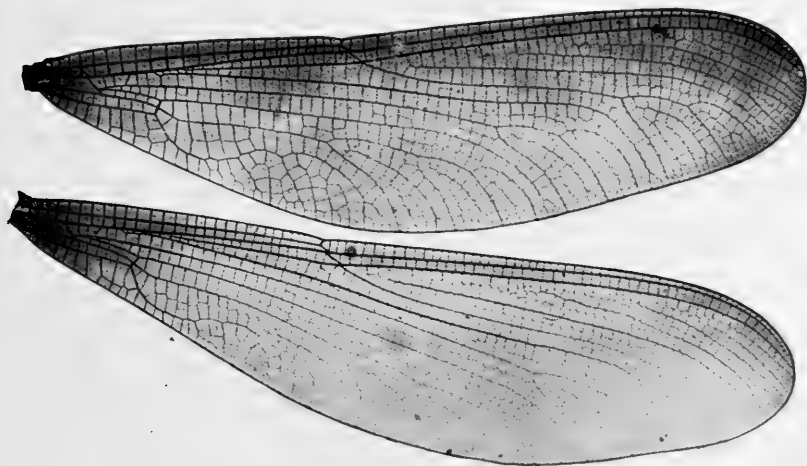


FIG. 15.—WINGS OF MALE *VESTALIS GRACILIS* FROM BURMA.

Abdomen, male 56 mm., female 49; hind wing, male and female 40. Two rows of cells between Cu_1 and Cu_2 for at least a short distance

from their origin, followed by one row, this single row breaking up near the wing margin as in *amana*. De Selys records the species for Palon (August and September) and Leitò (May). He states that the species occurs also in India, Thibet, and Cochin China.

MNAIS De Selys.

The Palearctic and Oriental species of this genus may be separated as follows:

Abdomen slender; stigma small, squarish, less brilliant, similar in adults of both sexes; wings more expanded, Cu_1 ending about or before the level of the nodus; stigma followed normally by one row of cells. Oriental.

Abdomen more robust; stigma twice as long as wide, red in the male, white in the female; wings less expanded, Cu_1 ending beyond the level of the nodus; stigma followed by 2 rows of cells. Palearctic.

17. MNAIS ANDERSONI McLachlan.

Material studied: Burma, collection P. A. N. S., 2 males, 2 females.

This species was originally described from Yunnan from 2 males, one of which, the first described, had the venation black and the wings slightly tinged with olivaceous, the other having the wings yellowish red.

De Selys^a writes that conditions exist intermediate between the olivaceous and yellow forms. I have before me 28 specimens of *Mnais* from Burma, and there are no intermediate forms. I therefore retain the name *andersoni* for the black-veined species, which may be described as follows: Abdomen, male 42 mm., female 37; hind wing, male 33 mm., female 32. Venation black, wing membrane very slightly tinged with olivaceous. The 2 males before me have the last 3 segments of the abdomen pruinose, the dorsum of the thorax not pruinose; the second segment of the antennæ is less than half yellow, and the stigma is smaller than in the yellow-winged species. The 2 females listed under "material studied" are referred to this species solely because they were associated with the males. They are green, bronzy, especially on the thorax and last abdominal segments; the second segment of the antennæ is largely yellow and the stigma is dull red.

^aOdonates de Birmanie, p. 485.

18. *MNAIS EARNSHAWI*, new species.

Material studied: Burma, collection Williamson, 22 males, 2 females. Abdomen, male 40 mm., female 34; hind wing, male 33 mm., female 30.

Male.—Venation yellowish red throughout, excepting that the costa becomes darker toward the wing base, wing membrane throughout tinged with bright yellow, slightly paler basal to the arcus and slightly denser along the anterior half of the wing on either side of the nodus, throughout with bright pink and violet reflections. The last 3 segments of the abdomen not pruinose in 6 of 17 specimens; the dorsum of the thorax pruinose in 19 specimens, but not pruinose in 1 very teneral individual. So far as my material goes this difference in pruinescence seems to clearly indicate specific differences between *andersoni* and *earnshawi*; in the case of *andersoni* the pruinescence is first

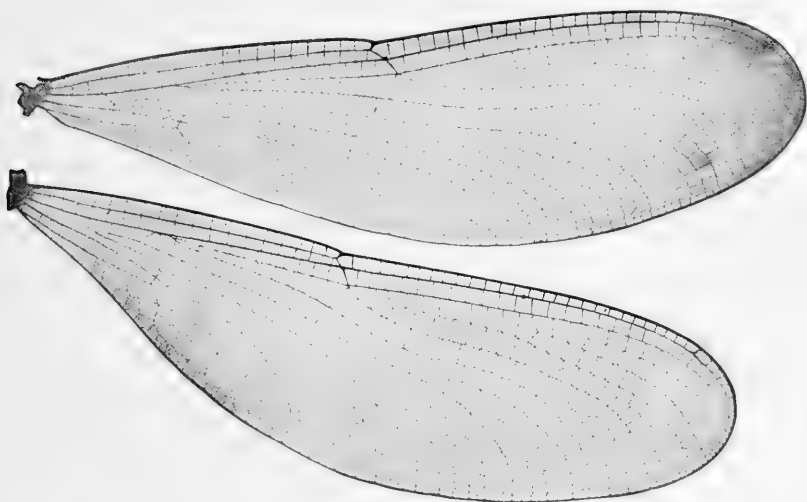


FIG. 16.—WINGS OF FEMALE *MNAIS EARNSHAWI* FROM BURMA.

clearly marked on the last abdominal segments, and if it appears at all on the thorax it is at a stage of maturity not reached by the 2 apparently mature males I have seen; *earnshawi*, on the other hand, becomes pruinose first on the thorax, and it is only in more mature individuals that the pruinescence appears on the abdomen. Of 40 antennæ of *earnshawi* examined 13 had the second segment about $\frac{1}{2}$ yellow, while 27 had this segment more than $\frac{1}{2}$ yellow. Of 70 wings of this species 7 wings had two rows of cells for at least a short distance in the poststigmal costal space. A very teneral male has the wings and stigma pale salmon in color. The 2 females in this case, as in the case of *andersoni*, are referred to *earnshawi* only because of their association with the males. One of them, somewhat teneral, has the body colors bright green throughout; the second segment of the antennæ is yellow, excepting an apical point; and the stigma is dull white. In the other female the stigma on one front wing is all but wanting, being reduced

to a mere irregular speck of opaque tissue on either side of a postnodal cross vein. This female has the stigma dull reddish-brown in color.

The species is named for Mr. R. A. Earnshaw, Toungu, to whose friendly interest in obtaining material for me it is a pleasure to testify.

In discussing *M. andersoni*, De Selys^a says:

Leitò en avril et mai, Cobapò en septembre, octobre et novembre, Meteieò et Puepoli en septembre et octobre. Les exemplaires à réticulation et ailes sofrancées viennent de Cobapò au commencement de juin et d'octobre, un exemplaire moins prononcé de Iadò le 12 avril (Fea).

Male specimens of *Mnais strigata*, *costalis*, *andersoni* and *earnshawi* placed side by side indicate beautifully the parallel development of the genus in the two zoogeographical areas, *andersoni* suggesting *strigata* (from Japan), and *earnshawi* suggesting *costalis* (from Japan). With this parallelism in mind the coloration of the wings in this genus becomes an important specific character.

19. CLIMACOBASIS MODESTA (Laidlaw).

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February, 1899, 2 males, 3 females; Trong, Lower Siam, 3 males.

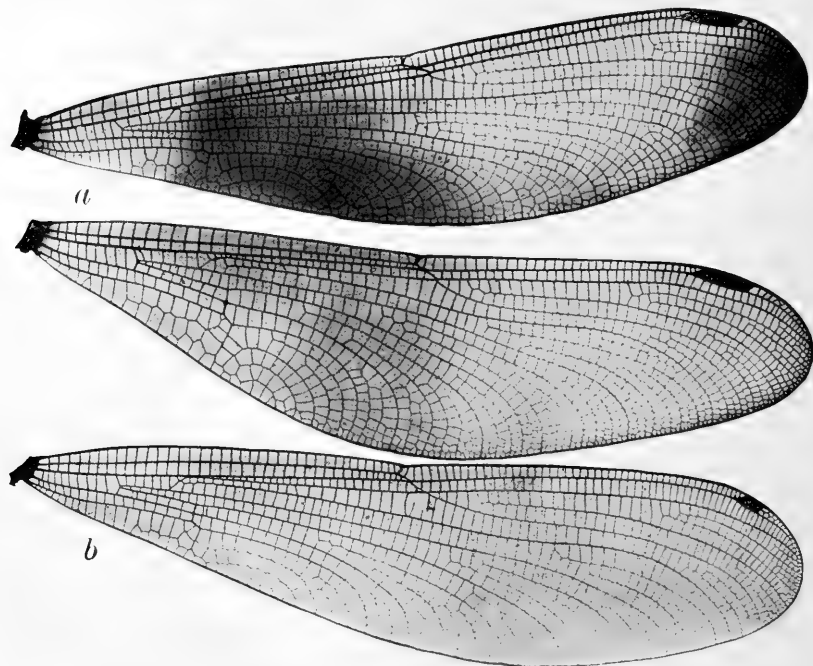


FIG. 17.—WINGS OF CLIMACOBASIS MODESTA FROM SIAM. a, MALE; b, FRONT WING OF FEMALE.

In Mr. Laidlaw's description of *Climacobasis lugens* (= *modesta*) the male is described as having the hind wing 47 mm. in length. Doubt-

^aOdonates de Birmanie p. 486.

less this is a mistake, 37 being intended. A male and female from Siam measure as follows: Abdomen, male 54 mm., female 46; hind wing, male 39 mm., female 41. Wings of both sexes have the violet and green reflections almost universal in this subfamily.

20. *NEUROBASIS CHINENSIS* (Linnæus).

Material studied: Burma, collection P. A. N. S., 2 males; collection Williamson, 3 males. Siam, collection U. S. N. M., Trong, Lower Siam, 6 males, 3 females; Khaw Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February, 1899, 1 male.

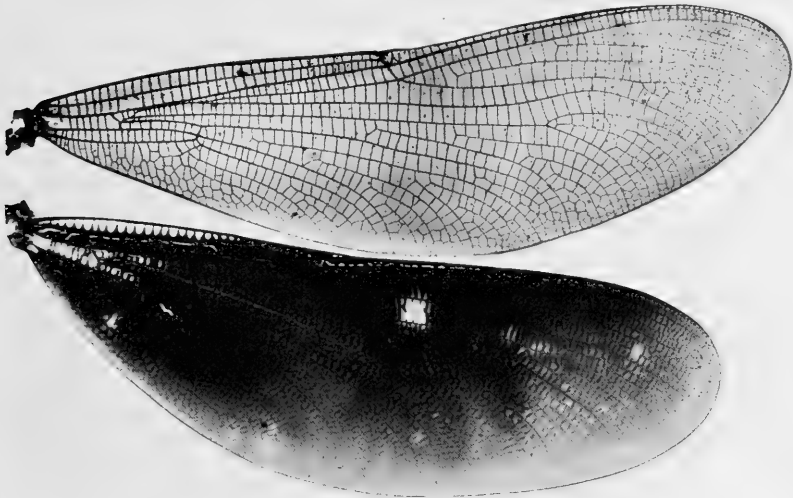


FIG. 18.—WINGS OF MALE *NEUROBASIS CHINENSIS* FROM SIAM.

De Selys in *Odonates de Birmanie* records *chinensis* from "Monts Carin en avril; Puepoli en juin; Bhamo en juillet (Fea)." Mr. Kirby has recorded the species for Upper Burma and Hassan Abdal. Mr. Laidlaw took the species on the Aring River, in Kelantan; and De Selys in 1897 (*Causeries Od.*) gives as "Patrie: Inde, Thibet, Khazya Hills, Cochinchine, Sumatra, île du Prince-de-Galles."

21. *MATRONA NIGRIPECTUS* De Selys.

This species is not represented in the material before me. De Selys has recorded it from the Khasia Hills, Puepoli (June) and Leitò (September).

SUMMARY.

Twelve genera and twenty-one species of the subfamily Calopterygine are known from Burma and Lower Siam. In the preparation of this paper a total of 233 specimens have been studied,

ON THE LIPARIS (TRISMEGISTUS) OWSTONI JORDAN AND SNYDER.

By PETER SCHMIDT,

Of the Academy of Sciences, St. Petersburg.

There was recently described by Prof. David Starr Jordan and J. O. Snyder^a a new Liparidid from the deep waters of Japan, which they believed to represent a new genus and species, namely, *Trismegistus owstoni*. By chance a second specimen of this interesting and undoubtedly new form is in a collection of Japanese fishes which I brought home from my journey to Japan in 1901, and so I can in some respects complete the description given by the previously mentioned authors.

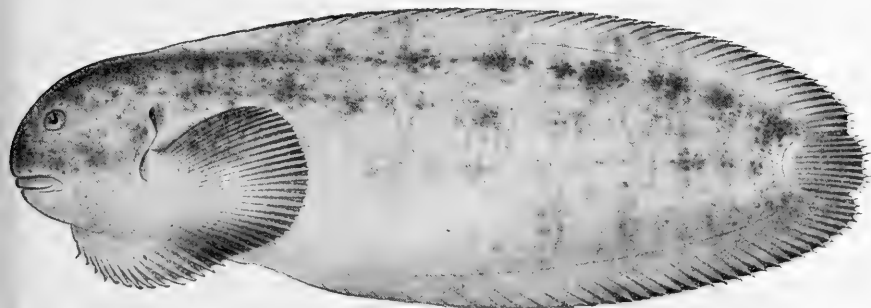


FIG. 1.—LIPARIS OWSTONI.

A minute comparison of my specimen with the original description has shown that it is undoubtedly the same form as that described, but I can not agree with the opinion of President Jordan and Mr. J. O. Snyder that it must be regarded as representing a new genus, differing from *Liparis*. This new genus differs from *Liparis*, according to these eminent American ichthyologists, only "in having the skin rough with prickles, with broad, rounded bases like thumb tacks." This peculiarity can of course be regarded as a generic one, but I must call

^a On a Collection of Fishes made by Mr. Alan Owston in the Deep Waters of Japan. *Smiths. Miscell. Coll.*, XLV, 1904, p. 238, pl. LVIII.

attention to the following facts: We know another *Liparis* which has the same peculiarity. It is covered, and often very densely covered, with osseous prickles. It is regarded as a variety of a very common Arctic species, *Liparis fabricii* Kröyer (= *L. tunicata* Reinhardt). Long ago this form was described by C. F. Lütken^a as *Liparis fabricii* Kröyer forma *leprosa*^b and figured by him on his Plate XV, fig. 5. In the zoological museum of the Imperial Academy of Sciences of St. Petersburg we have some still undescribed specimens of this variety, brought by Mr. N. M. Knipovitch from Murman, on the coast of Lapland. By the kind permission of Mr. Knipovitch I have compared the structure of the prickles of both forms. The prickles of *Liparis fabricii leprosa* are exactly like those of the Japanese form. They are also armed each with a sharp spicule, but the plate is not so flat as in *Liparis owstoni*. It is more conical, though of the same character. It has even the same radiating striations. I believe that if a peculiarity is not even of a specific value (other varieties of the same *Liparis fabricii* have no such prickles at all) it can not be taken as the distinction of a genus. In all other respects the new Japanese form is a true *Liparis*, of course of gigantic dimensions, but entirely like—for instance, *Liparis agassizii* Putnam—as already mentioned by Prof. D. S. Jordan and J. O. Snyder.

My specimen is a little larger than the type; its total length is 457 mm.; length to base of caudal fin, 417 mm.; it is a full-grown female filled with eggs, which was purchased by me in the fish market at Nagasaki, in April, 1901, and is now catalogued in the ichthyological collections of the zoological museum of the Imperial Academy of Sciences in St. Petersburg as No. 13173. Japanese fishermen have informed me that it is a very rare form, with no Japanese name.

The fin formula of my specimen is D. 42, A. 34, P. 43, C. 10; head $4\frac{1}{5}$ in length measured to base of caudal fin; depth 5; eye 10 in length of head; snout $2\frac{1}{10}$; width of mouth $1\frac{3}{5}$; width of interorbital space $2\frac{1}{10}$. It differs from the described species by the width of the interorbital space, which is a little larger ($2\frac{1}{10}$ instead of $1\frac{3}{4}$), but I have no doubt that this is a difference of individual or possibly a sexual character (the sex of the described species is not given by the authors).

Interorbital space flat; gill rakers 1 + 7, like warts covered with setæ, placed in a double row on the inner and on the outer side of a gill arch; width of gill opening contained $2\frac{1}{5}$ times in the length of head; origin of dorsal at a vertical passing through a point about one

^aChr. F. Lütken. Et Bidrag til Kundsgab om Kara-Havets Fiske. Dijinphna Tagtets Zool.-Bot. Udbytte: Kjöbenhavn, 1886.

^bApparently *Liparis fabricii* belongs to the same group (*Trismegistus*) as *L. owstoni*. To settle finally the question of the generic value of these prickles, we should know under what conditions *L. fabricii* is without prickles; whether these structures be seasonal, sexual, dimorphic, rudimentary, or on localized individuals. In other words, what is the real significance of Lütken's "forma *leprosa*."—D. S. J.

diameter of eye behind base of pectoral; origin of anal below tenth dorsal spine; both fins united with the caudal, but their tips reaching to the end of second third of the length of caudal, and not as described and figured by Messrs. Jordan and Snyder. The caudal fin of the American specimen (see fig. 1) conveys the impression that it has been broken on the tip and restored by the artist.

Skin thick and loose, in irregular folds, covered with thumb tack-like plates which make it rough; a broad longitudinal band on the side in the middle between dorsal and anal smoother. These plates cover also the outer side of basal parts of pectoral fins; caudal not convex

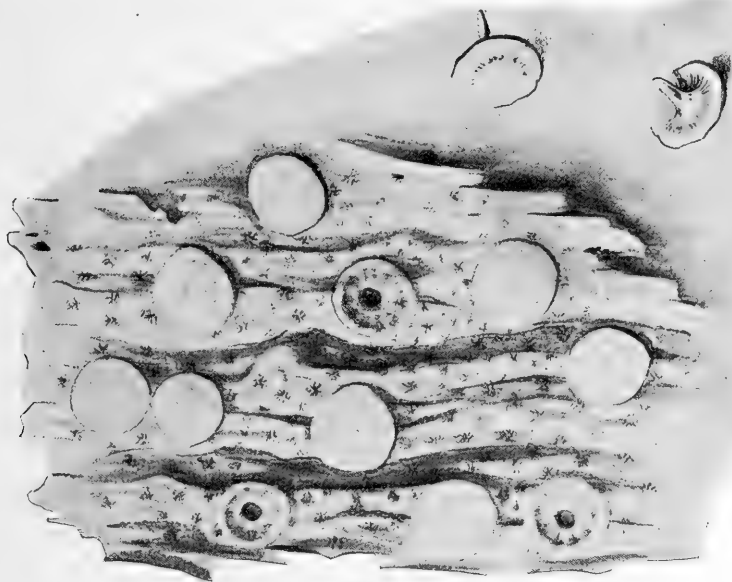


FIG. 2.—*LIPARIS OWSTONI*, SKIN WITH PRICKLES.

posteriorly, the posterior margin of the fin completely truncate; pectorals as described by Messrs. Jordan and Snyder. Disk oval, with thin margins; its longitudinal diameter contained $2\frac{5}{6}$ times in the length of head. The distance of the anal opening from the hind margin of the disk is equal to the width of the mouth. Color gray-yellowish, clouded with darker gray and blackish on the dorsal side; margin of the hind part of dorsal, caudal fin, and anal with base of them blackish; pectoral dark gray, on the inner or posterior side blackish.

I believe that all of these slight discrepancies noted above do not indicate specific difference, and that my specimen belongs to the species *Liparis* or *Trismegistus owstoni*.

ON A COLLECTION OF FISHES MADE IN KOREA, BY
PIERRE LOUIS JOUY, WITH DESCRIPTIONS OF NEW
SPECIES.

By DAVID STARR JORDAN and EDWIN CHAPIN STARKS,
of the Stanford University.

In 1885, the late Mr. Pierre Louis Jouy, then an assistant to the United States National Museum, visited Korea from Japan, making a considerable collection of fishes for the United States National Museum. We give in this paper a list of the species contained in that collection and those obtained by Ensign J. B. Bernadou, U. S. N., in the vicinity of Chemulpo, where he collected from September, 1884, till April, 1885, with descriptions of those new to science. It is evident that the marine fauna of Korea is essentially that of Japan, while that of the rivers is different as to species, and is as yet practically unknown. The plates accompanying this paper are drawn by Mrs. Chloe Lesley Starks. For the opportunity of studying the collection we are indebted to the courtesy of Mr. Richard Rathbun, Assistant Secretary of the Smithsonian Institution.

Family EPTATRETIDÆ.

1. EPTATRETUS BURGERI (Girard).

Fusan.

Family CLUPEIDÆ.

2. HARENGULA ZUNASI (Bleeker).

Gensan.

Apparently the name *Sardinella* was first used for a species, properly referable to the genus later called *Sardinia* by Poey. The name *Clupanodon* should, in our present view, be restricted to the first species named under it, in which case it is equivalent to *Comosirus* of Jordan and Snyder.

Family ENGRAULIDIDÆ.

3. ENGRAULIS JAPONICUS Schlegel.

Gensan.

4. TRICHOSOMA HAMILTONII (Gray).

Anal 38. Gill-rakers nearly as long as eye; 16 on lower limb of arch. Maxillary reaches to base of lower pectoral ray. Ventral scales 15+10.

A single specimen in the collection labeled "Korea."

5. SETIPINNA GILBERTI Jordan and Starks, new species.

Dorsal 1, 11; anal 57; scales 44 (!). Head, " 5 in length; depth, $3\frac{1}{5}$. Eye, $4\frac{1}{5}$ in head; snout, $5\frac{1}{2}$; maxillary, $1\frac{1}{10}$; interorbital width, $3\frac{1}{5}$.

Snout short, projecting but slightly beyond mouth. Maxillary reaching to within a little less than the diameter of the pupil of the

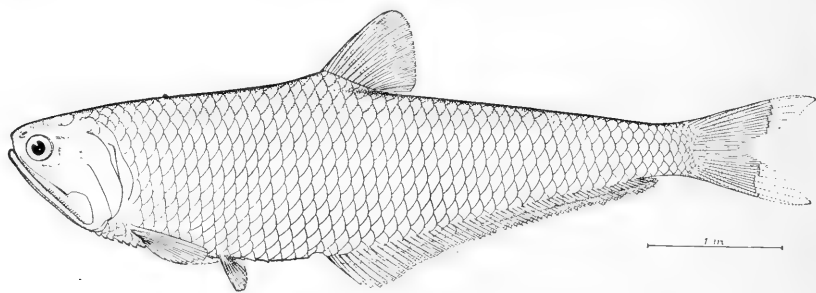


FIG. 1.—SETIPINNA GILBERTI.

edge of the opercle; its end dilated into a thin semicircular lamella behind. Teeth on maxillary a little larger than those on mandible. Gill-rakers slender, their number 13+16.

Scales nearly all missing on our specimens. A series of 4 on the posterior part of the body of the type occupy about the same space as a like number just behind the pectoral. Measuring with these as a standard there would be 44 scales in a longitudinal series. There are 18 ventral scales before the ventrals and 8 behind.

Dorsal with short stout spine, scarcely attached to the dorsal rays. Base of first dorsal ray nearer tip of snout than base of caudal by a distance equal to the postorbital part of head, or to the length of dorsal base. Pectoral filament longer than the head by one diameter of the eye; its tip reaching very slightly past tips of ventrals.

Ventrals inserted midway between front of anal and base of pectorals. Ventrals contained $3\frac{1}{2}$ times in head. Front of anal under the

"All of the measurements pertaining to the head in this group are taken obliquely from the tip of the snout to a little above the pectoral fin, the greatest length of the head.

first or second dorsal ray. Anal base shorter than half entire length (without caudal) by half the diameter of eye.

Color uniform silvery on head and sides, shading into light brown on back. Fins all colorless.

The body of this species is more slender than in either *S. melanochir* or *S. taty*; the height being nearly a fourth of the length rather than a third, or less than a third. The origin of the anal is under the anterior dorsal rays and the pectoral filament is short as in the former species, but the origin of the dorsal is nearer the snout than base of caudal and the number of anal rays is greater as in the latter species.

The type is 145 mm. in entire length and labeled "Korea." It is numbered 37766, U. S. National Museum, and was collected by Ensign J. B. Bernadou, U. S. N., at Chemulpo, 1884-1885.

A cotype from Ninsen, Korea, was presented by the Imperial Museum, Tokyo, Japan. It is numbered 8659, Ichthyological collections, Stanford University.

Named for Dr. Charles H. Gilbert.

Family SALMONIDÆ.

6. PLECOGLOSSUS ALTIVELIS Schlegel.

Korea.

Family CYPRINIDÆ.

7. CYPRINUS CARPIO Linnæus.

Common.

8. CARASSIUS AURATUS (Linnæus).

Common.

9. OCHETOBIOUS LUCENS Jordan and Starks, new species.

Dorsal 11; anal 11; scales 65; 9 from dorsal and 4 from anal to lateral line. Head 5 in length; depth $6\frac{3}{4}$. Eye $4\frac{1}{4}$ in head; snout 4; maxillary $3\frac{1}{2}$; interorbital space $3\frac{3}{4}$.

Body elongate and compressed; head pointed. Snout rather sharp, scarcely longer than eye, jaws even when mouth is closed; the lower with a slight projection on upper edge at symphysis. Maxillary reaching to below anterior margin of eye. Interorbital space evenly rounded; large supraorbitals forming its outer edges. Gill-rakers numerous, long and slender, those near the angle of the arch half as long as eye; 6+22 in number. Pharyngeal teeth rather slender and slightly hooked, 5, 4, 2-2, 4, 4 in number.

Scales moderate in size, thin and not very firmly attached. Lateral line bending downward and running along lower half of side and through middle of caudal peduncle; no abrupt bends in it anywhere.

Dorsal nearer tip of snout than base of caudal by a distance equal to $1\frac{1}{2}$ times the eye; its posterior outline very slightly concave; length

of anterior rays contained $1\frac{2}{5}$ times in head; when fin is depressed the anterior rays reach beyond the tips of the last. First anal ray is nearer base of caudal than base of first ventral ray by one diameter of eye. Insertion of ventrals directly under first dorsal ray; length of ventrals $1\frac{3}{5}$ in head; that of pectoral $1\frac{1}{2}$. Caudal forked.

Color bright silvery, blue brown on back, shaded rather abruptly to the silver below. Fins all colorless. Peritoneum white.

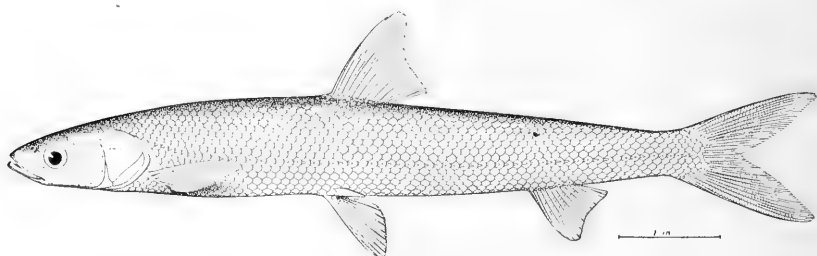


FIG. 2.—*OCHETOBIUS LUCENS*.

This species is close to *O. elongatus* (Kner.). The eye is larger, the maxillary reaches farther back, the snout is shorter as compared with the eye, and the interorbital space is narrower.

The type and sole specimen was collected by Jouy at Chemulpo, Korea; it is 20 cm. in entire length, and is numbered 51496, U. S. National Museum.

1. *LONGURIO* Jordan and Starks, new genus.

Body very elongate and nowhere compressed. Snout rounded and projecting beyond an inferior V-shaped mouth. A barbel present at

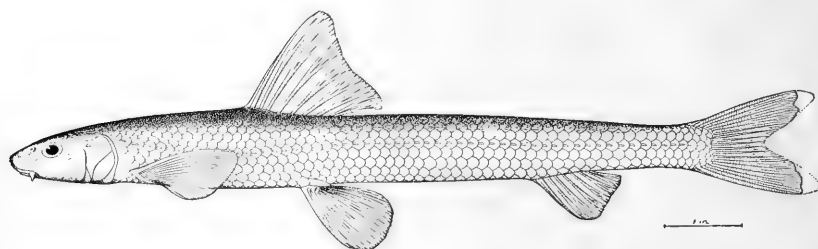


FIG. 3.—*LONGURIO ATHYMIUS*.

the end of maxillary. Pharyngeal teeth 5, in a single row, some of them molar-like. Scales moderately large. Lateral line running through middle of caudal peduncle. Dorsal without osseous ray, placed rather anteriorly, its anterior half or more in advance of ventrals. This genus seems to have some affinity with *Pseudogobio*, but the relationship is not at all close.

10. *LONGURIO ATHYMIUS* Jordan and Starks, new species.

Head, $6\frac{1}{10}$ in length; depth, $9\frac{1}{2}$. Dorsal, 9; anal, 8; scales, 55. Eye, $5\frac{1}{2}$ in head; snout, $2\frac{1}{5}$; maxillary, $3\frac{1}{4}$; interorbital space (bone only), $3\frac{1}{8}$.

Body elongate; not compressed; the back not at all elevated; tapering very slightly and gradually to the caudal peduncle. Snout blunt and rounded, projecting beyond the mouth a distance equal to three-fourths the diameter of the eye. Mouth broadly V-shaped, entirely inferior, the tips not thickened. Maxillary reaching to below posterior nostril, its end with a barbel nearly equal in length to the eye. Eye elliptical; its length contained $1\frac{3}{4}$ in snout. Gill-rakers short and weak, 3×14 in number. Pharyngeal teeth 5 in single row; the anterior 2 blunt and rounded, the others with a concave surface.

Scales large, rather firmly attached and regularly arranged; an enlarged scale at base of ventral. Lateral line slightly bending down anteriorly and running straight backward through middle of caudal peduncle.

First ray of dorsal placed at the beginning of the anterior third of the distance between base of caudal and tip of snout. Posterior edge of dorsal concave; the height of its anterior rays exceeds the length of the head by half the diameter of the eye. Length of pectoral equal to length of head. Insertion of ventrals below sixth or seventh dorsal ray; length of ventrals $1\frac{1}{4}$ in head. First anal ray from base of caudal a distance equal to that between base of pectoral and base of ventral. First ray of anal and dorsal unbranched, shorter than the second, to which it is rather closely attached; last ray branched to base. Caudal broken, but apparently it was slightly forked.

Color silvery, brownish on back. The type is a badly faded specimen and no markings are evident.

The type and sole specimen is from Chemulpo, Korea; it measures 25cm. in entire length, and is numbered 51495, U. S. National Museum.

2. *COREIUS* Jordan and Starks, new genus.

This genus is related to *Zezera* and *Rohita*. It differs from the former in having the dorsal anteriorly placed, the snout blunt and projecting beyond the mouth, and the eye with a broad, thin, annular eyelid; from the latter, in having large barbels, teeth in one row, lips without a horny cutting edge, and dorsal short.

11. *COREIUS CETOPSIS* (Kner).

Two specimens collected at Chemulpo, Korea, by Jouy. The following description is of the larger one, 10 cm. in length.

Dorsal 9; anal 8; scales 52; transverse series 6 from first anal ray, 7 from first dorsal ray in oblique series to lateral line. Head 5 in

length; depth $4\frac{3}{5}$. Eye inside of adipose eyelid 8 in head; orbit $6\frac{1}{4}$; snout $2\frac{1}{5}$; maxillary $3\frac{1}{2}$; interorbital width $3\frac{1}{3}$; height of caudal peduncle $1\frac{3}{5}$.

Body moderately elongate, compressed, tapering slightly in nearly straight lines from behind dorsal to a very broad thin caudal peduncle. Anterior dorsal profile rather steep from dorsal to end of snout; slightly depressed above eyes. Snout blunt, overhanging the small mouth by a distance equal to the distance between edges of adipose eyelid. Mouth wholly inferior and with very thick lips. Maxillary reaching to space between the large nostrils; a long barbel at its end equal to half the length of the head. Eye with a thin annular eyelid. Interorbital evenly convex. Gill-rakers very small, 3+10 on first arch. Pharyngeal teeth in a single row of 5 on a side; they are coarse, somewhat compressed, and have an elongate flap or slightly concave grinding surface.

Scales rather elongate posteriorly, many of them with an angle behind. Lateral line almost perfectly straight everywhere.

First dorsal ray placed midway between tip of snout and base of last anal ray. Length of dorsal base, $1\frac{3}{4}$ in head. First anal ray one diameter of eye nearer base of caudal than base of ventrals. Insertion of ventrals under fourth or fifth dorsal ray. Pectoral barely reaching base of ventral. Caudal badly broken, apparently forked.

Color so faded little of it can be made out. Back dark brown or slate brown, lighter below; dorsal dusky, pectoral growing dark toward tip; ventral slightly dusky; anal colorless.

12. ZACCO TEMMINCKII (Schlegel).

Several specimens from Fusan. They seem to differ from specimens from Kawatana, Japan, only in being a little darker in color, and in having the lateral band more diffused.

3. FUSANIA Jordan and Starks, new genus.

Form slightly compressed; moderately deep. Mouth terminal. No barbels present. Gill-rakers short and few in number. Pharyngeal teeth in two rows. Scales large; lateral line wholly absent. Dorsal without an osseous ray; placed behind the ventrals. Caudal slightly forked. Dorsal and anal with short bases. Abdomen not compressed to a sharp edge.

13. FUSANIA ENSARCA Jordan and Starks, new species.

Dorsal, 9; anal, 9; scales, 32; transverse series, 9. Head, $3\frac{3}{4}$ in length; depth, $3\frac{3}{4}$. Eye, $3\frac{1}{3}$ in head; snout, $4\frac{1}{5}$; maxillary $2\frac{3}{4}$; interorbital space, $2\frac{1}{4}$; height of caudal peduncle, 2.

Snout blunt, shorter than eye. Mouth terminal; the lower jaw slightly projecting; maxillary reaching to below front of pupil. Inter-

orbital space broad, and evenly convex. Gill-rakers very small, 8 on lower limb of arch. Pharyngeal teeth slender and pointed; in two rows; 5, 3-3, 4 or 5, in number.

Scales large, thin, and firmly attached. Lateral line wholly absent.

Dorsal with a short base, its first ray midway between tip of snout and tips of middle caudal rays; when fin is depressed its tip reaches to opposite last anal ray. First anal ray distant from the caudal base once the length of the head.

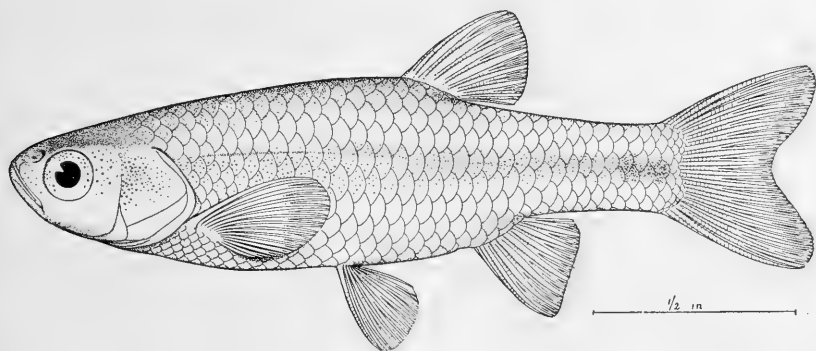


FIG. 4.—*FUSANIA ENSARCA*.

Insertion of ventrals in front of the dorsal a distance slightly exceeding the length of the eye. Pectoral reaching to within half the diameter of the eye of the ventral. Caudal moderately forked; the outer rays exceed the length of the middle rays by one diameter of the eye. Color: under parts silvery, back brown blending gradually downward. A much-diffused lateral band is present, growing darker posteriorly. Dorsal and caudal slightly dusky, other fins colorless.

The type and several cotypes were taken by Jouy at Fusan, Korea. They are from 40 to 58 mm. in length. The type is numbered 45265, U. S. National Museum.

14. *LEUCISCUS HAKUENSIS* Günther.

Gensan.

15. *LEUCISCUS SEMOTILUS* Jordan and Starks, new species.

Dorsal 9; anal 9; scales 66; 9 scales from anal and 12 from dorsal to lateral line. Head $3\frac{1}{2}$ in length; depth $4\frac{1}{2}$. Eye $4\frac{1}{2}$ in head; snout $3\frac{1}{4}$; maxillary $2\frac{3}{4}$; interorbital space 3; height of caudal peduncle $2\frac{1}{2}$.

Body moderately elongate, the head wide and very blunt. Snout blunt; as viewed from the side the outline is continuous with the nearly straight profile of head to above the nostrils where it curves rather steeply downward. Mouth broad and terminal, the lower jaw included. Maxillary reaching to below anterior margin of pupil. Interorbital space wide and evenly curved. Gill-rakers scarcely developed.

Pharyngeal teeth long, but not very sharp; the longer row of four or five teeth, the shorter usually with only one tooth, though sometimes with two.

First dorsal ray midway between base of caudal and front of eye; posterior margin of dorsal not concave, the long anterior rays do not reach past the posterior ones when fin is depressed. First anal ray distant from caudal base a third the length of body without caudal. Insertion of ventrals a little in front of the dorsal. Caudal forked or lunate when fin is extended.

Color brown mottled with darker scales. Belly dusky brown. A black streak along median line of back, and a diffused lateral streak, more conspicuous posteriorly. A large dark brown very conspicuous spot on base of dorsal rays; a lighter more diffused spot at base of caudal rays. Other fins slightly dusky.

This species somewhat resembles *L. jouyi* but is without the deep caudal peduncle.

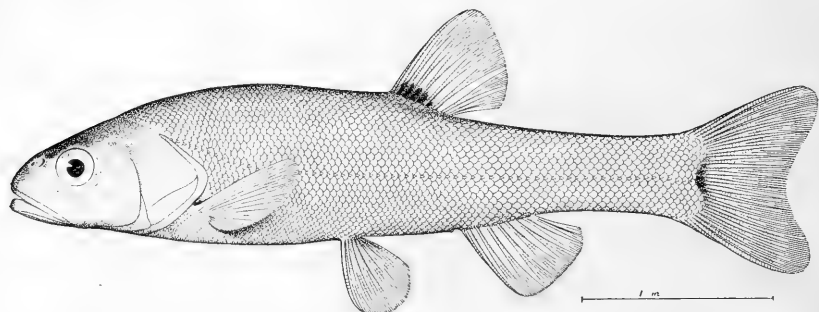


FIG. 5.—*LEUCISCUS SEMOTILUS*.

Several specimens taken in a fresh-water stream near Fusan, Korea, by Jouy.

The largest specimen is 125 mm. in length. The type is numbered 51500, U. S. National Museum.

Cotypes are numbered 8562, Ichthyological collections, Stanford University.

16. *LEUCISCUS TACZANOWSKII* Steindachner.

Gensan.

17. *PARAPELECUS JOUYI* Jordan and Starks, new species.

Dorsal 9, the first ray short unbranched; anal, 24, counting two short anterior rays; scales 40, $3\frac{1}{2}$ from first anal ray, $7\frac{1}{2}$ from first dorsal ray to lateral line. Head, $4\frac{1}{2}$ in length without caudal; depth, $4\frac{2}{5}$. Eye, $1\frac{1}{2}$ in head; snout, $3\frac{1}{2}$; interorbital space, $3\frac{3}{4}$; maxillary, 3.

Body moderately compressed and deep; the ventral outline more strongly convex than the dorsal; the entire ventral outline from isthmus to anal trenchant. Snout pointed, a little longer than eye. Posterior nostril long and narrow, its length contained $2\frac{1}{2}$ times in the

eye. Maxillaries strongly curved, reaching to below anterior margin of eye; a slight notch between them anteriorly to receive a sharp symphyseal knob. Jaws even in front when closed. Interorbital space rising obliquely from eye to the flattish median area. Gill-rakers small and sharp 2+10 in number. Pharyngeal teeth long, sharp, and slightly hooked; 5, 4, 2-2, 3, 4, in number.

Scales large and thin. Lateral line apparently as in *P. machærius*. Its course anteriorly can not be traced as the scales are absent in that region.

First ray of dorsal nearer base of caudal than tip of snout by a distance equal in length of second dorsal ray, which slightly exceeds combined length of snout and eye. Posterior edge of dorsal is straight: when fin is depressed all rays except the first are coterminous. First anal ray under tip of depressed dorsal. Anal base is contained $1\frac{1}{6}$ in head. Ventrals inserted entirely in front of dorsal, their tips are under the fourth dorsal ray.

Color of an old faded alcoholic specimen, bright silvery, dark brown on back; fins all light.

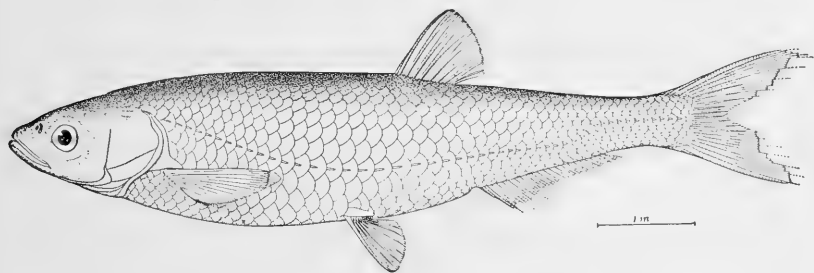


FIG. 6.—*PARAPELECUS JOUYI*.

This species differs from both *P. argenteus* and *P. machærius* in having much larger scales and a larger head.

The type and sole specimen is 20 cm. in length. It was taken at Chemulpo, Korea, by Jouy, for whom it is named. It bears the number 51497, U. S. National Museum.

18. *CULTER RECURVICEPS* (Richardson).

Chemulpo.

Family COBITIDÆ.

19. *MISGURNUS ANGUILLICAUDATUS* (Cantor)

Fusan.

20. *COBITIS TÆNIA* Linnæus.

Fusan and Gensan.

21. *ELXIS COREANUS* Jordan and Starks, new species.

Head $4\frac{1}{3}$ in length; depth, $5\frac{1}{3}$. Dorsal, 8; anal, 7; scales, 84. Eye, $5\frac{1}{3}$ in head; snout, 3; interorbital width, $3\frac{3}{4}$.

Head narrower than in *Elæis nikkonis*, the snout slightly more pointed. Barbels 8, about equal in length; a pair at nasals, 4 above

snout and one at end of each maxillary; no mandibular barbels present. Gill openings wholly lateral; joined to isthmus just below lower pectoral ray.

Scales small and cycloid, running in more or less definite oblique series, but the series are irregular and crowded, many of them extending only a short distance. Head entirely naked.

Front of dorsal midway between tip of snout and tip of caudal. Ventrals a very slight distance anterior to dorsal. Front of anal midway between insertion of ventrals and base of middle caudal rays. Caudal with many small axillary rays, which form a long keel on caudal peduncle above and below.

Color brown speckled, and spotted with darker brown. A dark blended lateral band extending at base of caudal in a conspicuous black spot, which runs out on caudal rays. A narrow dark streak through eye to tip of snout. Dorsal slightly spotted with brown. Wavy dark streaks across caudal rays; other fins light. Belly and under parts of head white. Other specimens are scarcely mottled, and have a dark,

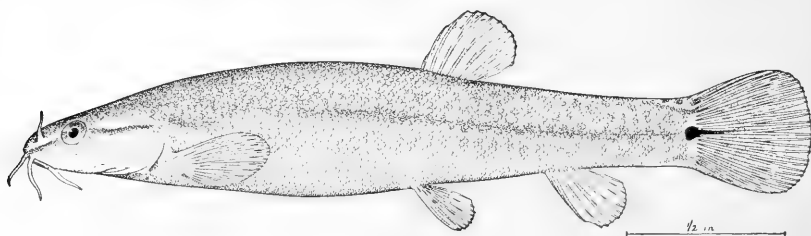


FIG. 7.—*ELIXIX COREANUS*.

clear-cut, broad, brown, lateral band in sharp contrast with the other body color.

This species may be known at once from *E. nikkonis* by the much smaller, more crowded scales. It is the best represented species in this collection, there being a couple of hundred specimens from Gensan and a few from Fusan.

The type is from Gensan, Korea, and is 63 mm. in length. It is numbered 45243, U. S. National Museum. Cotypes are numbered 8061 Ichthyological Collections, Stanford University.

Family POECILIIDÆ.

22. *APLOCHEILICHTHYS LATIPES* (Schlegel).

Many specimens were collected at Fusan. They have been compared with specimens from Wakanoura, Japan, and are apparently identical. The ventrals are not nearer to the operculum than to the vent, as described by Günther, nor midway between those points, as described by Schlegel, but nearer to the vent than to the operculum, as shown in Schlegel's figure.

Family SYNGNATHIDÆ.

23. SYNGNATHUS SCHLEGELI Kaup.

The dorsal covers 10 or 11 rings. Gensan.

Family AULORHYNCHIDÆ.

24. AULICHTHYS JAPONICUS Brevoort.

Fusan.

Family GASTEROSTEIDÆ.

25. PYGOSTEUS SINENSIS (Guichenot).

Pygosteus steindachneri JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVI, 1903, p. 61.

Gensan.

A single specimen, having but 7 spines. As *Gasterosteus sinensis* is described from "China" as having 7 dorsal spines, it is, without much doubt, identical with *Pygosteus steindachneri*.

Family EXOCOETIDÆ.

26. HYPORHAMPHUS SAJORI (Schlegel).

Gensan and Fusan.

Family MUGILIDÆ.

27. MUGIL CEPHALUS Linnæus.

Gensan.

Family SCOMBRIDÆ.

28. SCOMDEROMORUS SINENSIS (Lacépède).

Chemulpo.

Family CARANGIDÆ.

29. TRACHURUS TRACHURUS (Linnæus).

Gensan.

Family STROMATEIDÆ.

30. STROMATEOIDES ARGENTEUS (Euphrasen).

Chemulpo.

Family APOGONIDÆ.

31. APOGON LINEATUS Schlegel.

Fusan.

Family SPARIDÆ.

32. PAGRUS CARDINALIS (Lacépède).

Fusan.

33. SPARUS SCHLEGELI (Bleeker).

Gensan.

Family HÆMULIDÆ.

34. POMADASIS HASTA (Bloch).

A specimen 12 cm. in length.

Family SCIÆNIDÆ.

35. COLLICHTHYS LUCIDUS (Richardson).

A small specimen from Korea, Bernadou coll. D. IX-27. A. II, 12. Scales 60.

4. LARIMICHTHYS Jordan and Starks, new genus.

This genus is close to *Larimus*, differing in having cycloid scales, unequal teeth, weak anal spines, and more cavernous head.

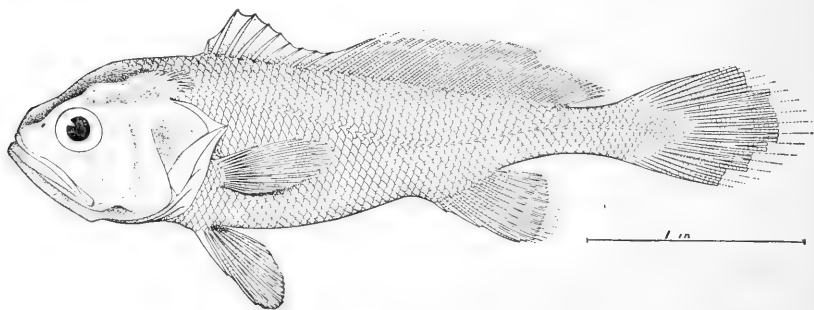


FIG. 8.—LARIMICHTHYS RATHBUNÆ.

36. LARIMICHTHYS RATHBUNÆ Jordan and Starks, new species.

Dorsal IX, 37; anal II, 10; few scales remaining, about 47. Head $3\frac{1}{2}$ in length; depth $3\frac{3}{4}$. Eye $3\frac{4}{5}$ in head; snout 4; interorbital space $3\frac{1}{5}$; maxillary $1\frac{5}{6}$; height of caudal peduncle 4.

Body compressed, deepest at the nape, tapering quickly backward to a rather narrow caudal peduncle; the outline under the dorsal fins forming a straight line. Mouth oblique; lower jaw projecting and with a low broad knob which fits into a shallow notch between premaxillaries. Anterior end of premaxillary on a level with middle of eye. Maxillary broad posteriorly reaching to below posterior margin of orbit; its whole length slipping under the transparent sheath projecting downward from suborbitals. Teeth in narrow bands, small and rather uneven, at intervals a curved tooth extends beyond the others, but they are scarcely long enough to be called canines. No teeth on vomer or palatines. Top of head and preopercular region rather cavernous. Gill-rakers long and slender, the longest $\frac{4}{5}$ the diameter of the eye.

Scales cycloid. A few scales on base of anal; no scales remaining on other fins. Lateral line curved up anteriorly and following the curve of the back.

Origin of spinous dorsal a little in front of pectoral base. Spines rather weak and low; the first spine scarcely half the length of the second and third which are the highest spines. They are scarcely longer than the orbit and not so long as the soft rays. The last spines are but little decreased in length making but a shallow notch between the spines and rays. The soft dorsal is long; the base of the last ray is one diameter of the orbit from the base of the caudal. Anal spines rather weak; the second $2\frac{1}{2}$ times the length of the first; the second about half the length of the soft rays and contained $3\frac{1}{4}$ times in the head. Length of anal base 3 times in head. Ventrals inserted a little in front of pectorals and reach half way from their insertion to the front of anal. Tip of pectoral opposite that of ventral. Caudal badly broken, apparently the middle rays were the longest as in *Larimus*; they were at least as long as the head posterior to the middle of the eye.

Color plain silvery, dark on back. Fins without markings or color.

The type and sole specimen was collected somewhere on the coast of Korea, by Jouy. It is 90 mm. in length and is numbered 45299, U. S. National Museum.

Named for Miss Mary J. Rathbun.

Family SILLAGINIDÆ.

37. SILLAGO SIHAMA (Förskål).

Family EMBIOTOCIDÆ.

38. DITREMA TEMMINCKI Bleeker.

Fusan.

Family LABRIDÆ.

39. HALICHÆRES PÆCILOPTERUS (Schlegel.)

Fusan.

Family TETRAODONTIDÆ.

40. SPHEROIDES ALBOPLUMBEUS (Richardson).

Chemulpo.

Family MONACANTHIDÆ.

41. STEPHANOLEPIS JAPONICUS (Tilesius).

Fusan.

Family OPHICEPHALIDÆ

42. OPHICEPHALUS ARGUS Günther

Chemulpo.

Family ANABANTIDÆ

43. ANABAS OLIGOLEPIS Bleeker.

Fusan.

Family SCORPÆNIDÆ

44. SEBASTISCUS MARMORATUS (Cuvier and Valenciennes).

Fusan.

45. SEBASTODES FUSCESCENS (Houttuyn).

Gensan.

Family COTTIDÆ.

46. TRACHIDERMUS ANSATUS (Richardson).

Chemulpo.

47. PSEUDOBLENNIUS PERCOIDES Günther.

Fusan.

48. FURCINA ISHIKAWÆ Jordan and Starks.

Fusan.

49. PARACENTROPOGON RUBRIPINNIS (Schlegel).

Fusan.

Family TRIGLIDÆ.

50. LEPIDOTRIGLA GÜNTHERI Hilgendorf.

Fusan.

Family GOBIIDÆ.

51. BOLEOPHTHALMUS CHINENSIS (Osbeck).

52. PERIOPHTHALMUS CANTONENSIS (Osbeck).

"Korea."

53. CORYPHOPTERUS VIRGATULUS (Jordan and Snyder).

Fusan and Gensan.

As the type of *Ctenogobius* (*fasciatus*) is said to have the tongue emarginate, the species with the tongue rounded, called *Ctenogobius* by Jordan and Snyder, and lately *Mugilogobius* by Professor Smitt, of Stockholm, may retain the name *Coryphopterus*, given to one of them by Doctor Gill. No type is assigned to *Mugilogobius* by Smitt, but the author of the genus informs me that the species on which it was based is *Ctenogobius abei* of Jordan and Snyder.

54. *CORYPHOPTERUS BERNADOUI* Jordan and Starks, new species.

Head $3\frac{1}{2}$ in length; depth 5; eye $3\frac{4}{5}$ in head; snout $3\frac{1}{2}$; maxillary $2\frac{3}{4}$. Dorsal VI–II; anal 11; scales 25.

Body robust; the head rather large and scarcely compressed; caudal peduncle deep, $2\frac{1}{5}$ in head. Snout rather short and blunt. Eyes large, separated by a narrow concave interspace; preorbital margin produced. Mouth oblique; lower jaw projecting; maxillary extending a little past the anterior margin of orbit, tongue rounded. Simple teeth in bands on jaws, the outer ones enlarged, a strong canine at each side of lower jaw. Gill openings not extending very far anteriorly; the isthmus broad, 3 in length of head. Gillrakers short and blunt, 2+10 on first arch.

Nape top of head behind the posterior margin of the eyes closely covered with small cycloid scales in about 24 series; similar scales on upper part of opercles. Scales on body finely ctenoid; the free edge

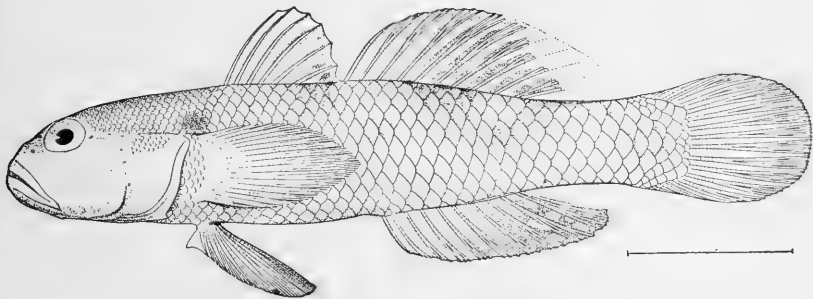


FIG. 9.—*CORYPHOPTERUS BERNADOUI*.

of most of them forming a right angle with the point directed backward; rather large cycloid scales on breast.

Dorsals well separated; when depressed the tips of the longest spines reach the base of the first soft ray; none of the spines produced; the soft dorsal slightly higher than the spinous. Origin of anal under third soft dorsal ray; anal rays a little shorter than those of dorsal. Pectoral scarcely reaching to vertical from vent, its tip slightly pointed. Caudal rounded.

Color of a rather faded alcoholic specimen, light, with 5 brown blotches on back and 5 similar ones on side below the interspaces of the former ones; the last spot at base of caudal; faint traces of longitudinal streaks on side. Spinous dorsal with a faint blotch posteriorly; soft dorsal with a brown streak down the membrane in front of each ray; the posterior ones narrowly divided into 2 or 3 spots. Anal light at base, growing dark toward tips of rays; 3 rows of conspicuous white spots across the posterior rays. Pectoral with a slight dusky tinge below; ventral rays dusky toward tips; caudal without color.

This is the only other *Coryphopterus* in the vicinity of Japan besides *C. abei* having scales on the upper part of the opercles. It does not otherwise resemble that species, being closer to *C. virgatulus* and *C. pflaumi*, from which it differs, in addition to the scales on the opercle, in color, and in having the scales on nape and top of head smaller and much more numerous.

The type and only specimen 13 cm. in length collected by Jouy and labeled "probably Korea." It is numbered 51499, U. S. National Museum.

55. *CHÆNOGOBIUS MACROGNATHOS* (Bleeker).

Gensan and Fusan.

56. *CHLOEA SARCHYNNIS* Jordan and Snyder.

Gensan.

We may here call attention to a mistake in the description and key of *Chloea castanea* in Jordan and Snyder paper on the Goboid fishes of Japan.^a

Head $2\frac{2}{3}$ in length should be $3\frac{2}{3}$, or, as given in their tabulated measurements, 25 to 28 hundredths of length.

57. *CHASMICHTHYS GULOSUS* (Sauvage).

Chasmias misakius JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 761.

Fusan and Gensan.

The larger specimens do not have the white spots on sides arranged so conspicuously in cross series as in specimens from Japan, and the dark spot at base of caudal is absent.

Two others are a uniform brown without markings. * The fins dusky.

58. *CHASMICHTHYS DOLICHOGNATHUS* (Hilgendorf).

"Korea."

59. *PTEROGOBIOUS ELAPOIDES* (Günther).

"Korea."

60. *ACANTHOGOBIOUS FLAVIMANUS* (Schlegel).

Fusan.

The maxillary in the species reaches variably from below the anterior edge of orbit to below the posterior edge of pupil.

61. *ACANTHOGOBIOUS HASTA* (Schlegel).

Dorsal IX-20; anal 16; scales 60. Head $4\frac{1}{3}$ in length without caudal; depth 8. Eye 9 in head; snout 3; maxillary $2\frac{1}{2}$; interorbital space 7; height of caudal peduncle $4\frac{1}{4}$.

Snout rather blunt, its upper outline turning at an angle at about its middle and steeply descending. Mouth large, lower jaw slightly

^aProc. U. S. Nat. Mus., XXIV, 1902, p. 79.

included; maxillary reaching slightly past front of eye. Interorbital slightly concave, a ridge on each side of it which converges with its fellow posteriorly, turns at a sharp angle and is continued downward a short distance behind eye. Teeth irregularly placed in one or two series on the side, in three or four on front of jaws; the outer series enlarged. Tongue truncate at tip. Gillrakers short, 4+9 on first arch.

No scales remain on body of our specimen. Nape and occipital region closely covered with small cycloid scales. Pectoral base and region in front of ventrals with similar, but thinner and less conspicuous scales. A small region near middle of cheek, another at upper part just behind eye and the upper half of opercle with circular scattered scales,^a nowhere in contact with each other; the naked areas on cheek are of much greater extent than the scaled areas.

First dorsal spine placed $1\frac{1}{2}$ times the length of the eye behind tip of opercular flap; the last spine connected by membrane to back, its base above tip of pectoral; base of spinous dorsal half length of head. Distance from base of last spine to first dorsal ray is slightly less than length of snout. Front of second dorsal nearer the snout than base of caudal by the length of snout; length of dorsal rays near middle of fin, $2\frac{1}{2}$ in head and only a little longer than the posterior rays. Origin of anal under fourth or fifth dorsal ray, under next to last dorsal ray. Length of ventral equals combined length of snout and eye. Caudal somewhat broken, but at least as long as head.

Color uniform brown on back, white below, spinous dorsal, ventral pectoral, and anal colorless; caudal dusky; each ray of soft dorsal is crossed by 5 or 6 spots, as shown in Schlegel's plate.

Length of specimen, 25 cm. It was collected at Chemulpo, Korea, by Jouy.

62. ACANTHOGOBIUS STIGMOTHINUS (Richardson).

Form and general appearance of *A. hasta*, but resembling *A. flavimanus* in number of fin rays and the markings on dorsals and caudal. The anal is edged with black and the ventrals are black edged with white. It may be at once known from *A. flavimanus* by the smaller mouth and more slender head and body; the spinules and the scales are finer and more regular, the scales much smaller.

A single specimen from Fusan.

^a Jordan and Snyder in *Gobioid Fishes of Japan* (Proc. U. S. Nat. Mus., XXIV, p. 102), suppose that this species has a naked head from Schlegel's picture. Schlegel says nothing on this point in his description, and they had no specimens. Gill's genus *Synechogobius* can not be retained, as *hasta* (the type) does not differ materially from *Acanthogobius* except in having 5 or 6 more dorsal rays. *A. stigmothinus*, though having the number of dorsal and anal rays of *A. flavimanus*, is similar to *A. hasta* in form and general appearance.

63. TRIDENTIGER OBSCURUS (Schlegel).

Gensan.

64. TRIDENTIGER BIFASCIATUS (Steindachner).

Fusan and Chemulpo.

The longitudinal stripes are not conspicuous.

Family PLEURONECTIDÆ.

65. PLEURONICHTHYS CORNUTUS (Schlegel).

Korea.

66. PLATICHTHYS STELLATUS (Pallas).

Gensan.

67. KAREIUS BICOLORATUS (Basilewsky).

Pleuronectes scutifer STEINDACHNER.

Gensan.

Family PTEROPSARIDÆ.

68. PARAPERCIS SNYDERI Jordan and Starks, new species.

Dorsal v-21; anal 17; scales 40; transverse oblique rows 3+10. Head $3\frac{5}{8}$ in length; depth $4\frac{1}{2}$. Eye $3\frac{1}{2}$ in head; snout $3\frac{3}{8}$; interorbital space $9\frac{1}{4}$; maxillary $2\frac{1}{3}$; height of caudal peduncle $2\frac{1}{4}$.

Body moderately elongate, a little compressed, head pointed as deep as wide; the anterior profile descends in a regular curve from dorsal to tip of snout. Jaws even, or the lower very slightly projecting. Teeth fine, set in a rather broad band on each jaw, the outer series enlarged. Small sharp teeth in narrow bands on vomer and palatines. Maxillary reaching to below front of pupil. Interorbital space narrow and flat, its width two-fifths of eye. Opercle with two spines on its posterior edge, the upper one larger than the lower, these on one or both sides may be divided at the tips irregularly into 2 or 3 points. Gill-rakers short 3+9 on first arch. Pseudobranchia large.

Scales everywhere roughly ctenoid; the spinules very numerous on each scale and close set. Cheek closely covered with 4 longitudinal rows of large scales; about three-fourths as large as those on the body. Lateral line arched for the greater part of its length; the arch slightly greater than the curve of the back.

Distance from tip of snout to first dorsal spine equal to distance from tip of snout to pectoral base; distance from first dorsal spine to first dorsal ray equal to distance from tip of snout to middle of eye. Third dorsal spine the longest, contained three times in head. The membrane of the last dorsal spine is slightly connected to base of first ray. The last dorsal rays when depressed reach to base of caudal rays.

First anal ray half the diameter of the eye nearer tip of snout than base of caudal. Anal coterminous with soft dorsal. Tip of inner ventral ray reaches to base of second anal ray; its length $1\frac{1}{10}$ in head. Length of pectoral equals length of caudal, which is $1\frac{1}{4}$ in head. Caudal truncate, its upper angle sharper than its lower.

Color light brown with 5 V-shaped dark blotches on back. A colorless lateral band, below which are 8 or 9 blended elongate cross spots. Head with several dark spots; a series of 3 or 4 white spots following lower edge of subopercle. Lips dark brown, and a dark spot at tip of mandible. Spinous dorsal dusky, soft dorsal opaque white with 3 or 4 small round transparent spots between each ray appearing like holes in the membrane. Caudal similarly marked, but the colorless spots are not confined to the membrane. A dark brown spot on base of lower pectoral rays. Other fins colorless.

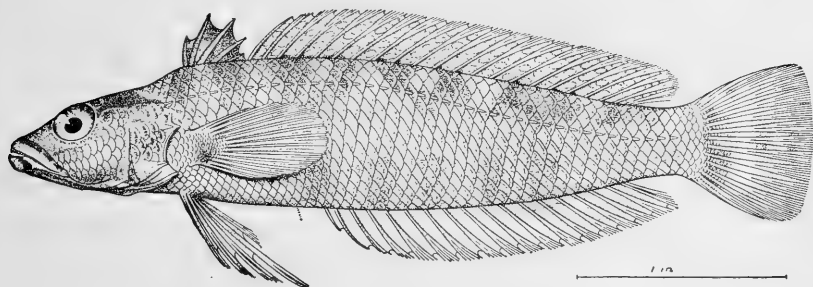


FIG. 10.—*PARAPERCIS SNYDERI*.

A specimen from Nagasaki, Japan, differs in having dark spots on dorsal and caudal, and the anal dusky. A light band extends downward from each eye.

This species differs from *Parapercis cylindrica* in having 40 instead of 50 scales in lateral line, the ventrals and spinous dorsal shorter, and the color markings different.

The type is labeled Korea without more definite locality. It is 97 mm. in entire length, and is numbered 51498, U. S. National Museum. A cotype is in the collections of the Stanford University Museum. It was collected at Nagasaki, by Jordan and Snyder.

Family CALLIONYMIDÆ.

69. *CALLIONYMUS VALENCIENNESI* (Schlegel)

Fusan.

Family BLENNIIDÆ.

70. *PHOLIS TACZANOWSKI* (Steindachner).

Gensan and Fusan.

Family ZOARCIDÆ.

71. ZOARCES GILLII Jordan and Starks, new species.

Dorsal 84, XIX, 14; anal 80+. Head $5\frac{3}{8}$ in length; depth 10. Eye 5 in head; maxillary $2\frac{1}{8}$; snout $3\frac{1}{8}$.

Head not at all compressed, as wide as deep. Snout very blunt, its upper surface on same curve with top of head, but toward its tip bluntly angulated and turning steeply downward. Eye at extreme upper profile of head. The interorbital space flat and wide; the extreme width is contained $3\frac{3}{4}$ times in head; the bone, only $6\frac{1}{2}$ times; the interorbital bone, is rather deeply concave for its full width, not channeled along its middle.

Maxillary reaching to below posterior margin of pupil. Lower jaw included. Teeth sharp and more irregular than in *Z. longatus*; in a single row except in front where 3 or 4 teeth on each side form a double row. Gillrakers short and sharp; 3+14 on first arch.

Scales small, circular, and partially embedded; front of anal and dorsal naked; breast behind base of ventrals with scales.

Second ray of dorsal is directly above gill opening.

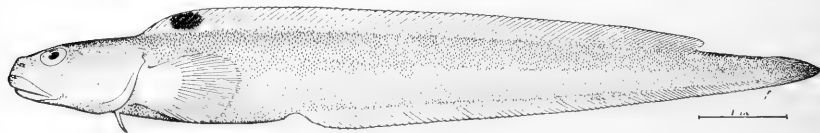


FIG. 11.—ZOARCES GILLI.

Front of anal twice the length of the head from tip of snout. Pectoral broad and rounded; its length $1\frac{1}{2}$ in head. Length of ventrals $\frac{3}{8}$ diameter of eye; tips of ventrals just reach to base of pectoral rays.

Color: Back light brown, abruptly changing to white at middle of sides; a narrow, light band along back a little distance below base of dorsal posteriorly separates the greater portion of the black color in this region into a lateral band. Twelve large inconspicuous blotches, larger than the spaces between them, along sides. Top of head dark brown, the sides light brown with white spots marking the position of small pores, lower part of head white. Dorsal, light dusky brown; a very conspicuous large, dark-brown spot on front of dorsal, the dorsal margined above it with white. Anal dusky, bordered with lighter posteriorly; its greater part white. Other fins white.

This species differs from *Z. longatus* in having a wide, flat interorbital space; the eyes placed at the upper profile of head; in having a longer spinous dorsal and particularly in color. A specimen of *Z. longatus* from Iwani in Shiribeshi, Japan, in the ichthyological collection of Stanford University has the head compressed, the interorbital strongly convex, the bone narrow, and high above the eyes.

The type and sole specimen is 24 cm. in length. It was taken at Fusan, Korea, by Jouy, and is numbered 45355, U. S. National Museum.

Named for Dr. Theodore Gill.

THE MOUNT VERNON METEORITE.

By WIRT TASSIN,

Assistant Curator, Division of Mineralogy.

The meteorite here described was found on the farm of Capt. S. T. Fruit, in Mount Vernon Township, about 7 miles northeast of Hopkinsville, Christian County, Ky. Although known for some thirty-five years, its meteoric origin was not suspected until 1902, and the first published account and preliminary description was given by Dr. George P. Merrill,^a in the *American Geologist* in 1903, from which the following is taken:

The meteorite, which is a pallasite, has been known for some thirty-five years by the occupant of the premises, where it served as a convenient stone on which to clean boots after crossing the muddy fields. Although recognized as of a peculiar type of stone, no suspicion of its meteoric nature was entertained, and it was only when the zinc and lead mining excitement of 1902 caused a sample of it to be sent to Mr. E. O. Ulrich, of the United States Geological Survey, with a request for information, that its true nature became known. It is through the influence of Mr. Ulrich that the specimen was obtained for the National Museum.

Prolonged exposure has, naturally, brought about a great amount of oxidation to the exterior portion of the material. More than that, the rough usage to which the exposed portion was subjected and the breaking away of small masses by the curious and the prospector, have so obscured the original form that little of value on this subject can be said. The mass [Plate III], as it came to the Museum, is in the form of a rude prism some 55 centimeters in height, with sides measuring 33 centimeters and 36 centimeters, respectively. Although badly oxidized, two of the sides show rough pittings. The weight, as received, was 351 pounds (159.21 kilos).

GENERAL STRUCTURE AND COMPOSITION.

A cut surface (Plate IV) shows the mass to be a pallasite of the Krasnojarsk type (Pk), consisting essentially of nickel-iron occurring in cohering spongiform or reticulated masses containing olivine and varying amounts of troilite, schreibersite, carbon, chromite, and lawrencite.

^a Merrill, George P. A Newly-found Meteorite from Mount Vernon, Christian County, Ky. *American Geologist*, xxxi, March, 1903, p. 156.

The nickel-iron constituent comprises about one-third of the mass of the entire surface as cut, and serves as a matrix in which are contained rounded blebs of olivine varying in size from 1 to 30 millimeters in diameter. Dislodging the olivine blebs will in general disclose a very thin, black, specular film more or less completely lining the entire cavity, and which is rich in carbon and usually contains some chlorine as chloride, together with more or less sulphur as sulphide. Next to this is frequently found a more or less continuous layer of schreibersite or troilite, or both. These in turn are followed by the nickel-iron constituent made up of kamacite, taenite, etc.

The olivine blebs are quite commonly penetrated by cracks in all directions. These cracks may or may not be filled with other substances. In the former case they are charged either with metallic iron, the black, specular chlorine-containing material above referred to as commonly surrounding the olivine, and which often contains chromite; with limonite (probably resulting from the oxidation of the specular substance), and which also contains chromite; or, and this but rarely, with schreibersite or troilite.

The mass contains, approximately, the following percentage composition, calculated from the results of several analyses:

Olivine	63.15
Nickel-iron	33.12
Schreibersite	1.95
Troilite .....	.69
Chromite	1.00
Carbon .....	.09
Chlorine	Trace.

This agrees fairly well with the composition of the mass as determined by the measurement of the areas of its constituents, the mean of some three hundred measurements giving the following values:

Olivine	61.75
Nickel-iron	36.52
Schreibersite	1.35
Troilite .....	.38

THE MINERALOGICAL COMPOSITION.

Some 400 grams in all of the mass were taken for separation and analysis, and in the several portions of this the following were separated:

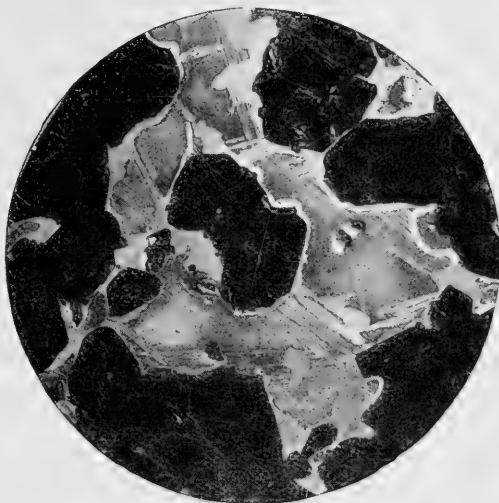
The nickel-iron alloy.—This constituent approximates one-third of the whole. It occurs in cohering spongiform masses of irregular shapes, some of them measuring a centimeter along their greatest diameters, while others are merely hair-like filaments.

Etching shows that the mass of the iron constituent is made up of a darker colored alloy in which is seen fine lines of a tin-white color (see figure), which are in part oriented and in part penetrate the mass in

zigzag shapes. Bounding this eutectic is seen a band of bright, white iron, which varies in width from a line to a millimeter.

Examined under the glass the mass of the iron constituent appears to be made up of minute octahedrons arranged in fine lamellæ, and considered as a unit may be defined as a granular octahedrite containing more or less numerous troilite and schreibersite areas.

Two portions of this constituent, each weighing 10 grams, were taken for analysis, and after treating with dilute acid for the separation of schreibersite, tænite, etc., were examined as follows: In one the silicon, iron, aluminum, copper, cobalt, nickel, and sulphur were determined; in the other the carbon and phosphorus, with the following results:



SECTION (MAGNIFIED) SHOWING STRUCTURE OF THE METALLIC PORTION.

Iron.....	82.520
Nickel.....	14.044
Cobalt.....	.949
Copper.....	.104
Sulphur.....	.288
Silica.....	.808
Aluminum.....	.410
Carbon.....	.465
Phosphorus.....	.390
Chlorine.....	Trace.

Tænite occurs in very thin, brittle, tin-white lamellæ, with a specific gravity of 7 at 20.1° C., and having the following composition:

Iron.....	63.99
Nickel.....	35.98
Cobalt.....	.10
Copper.....	Trace.
Phosphorus.....	.04

The material was strongly magnetic, but did not possess polarity.

Schreibersite occurs fairly abundantly, approximating as it does 1.35 per cent of the mass by measurement and 1.95 per cent by analysis. It is found bounding the olivine areas and occasionally penetrating or contained in them. The more common occurrence is, however, as blebs, veins, or filaments in the nickel-iron constituent. The mineral has a brilliant tin-white color, is strongly magnetic, possessing polarity,

and in one instance was undoubtedly crystallized, but, unfortunately, the specimen was so brittle that it fell to pieces on attempting to measure it.

An analysis gave the following:

Iron.....	64.990
Nickel.....	18.905
Cobalt.....	.105
Phosphorus.....	15.700
Copper.....	Trace.

Troilite occurs commonly associated with the black specular material lining the cavities containing the olivine in the nickel-iron constituent. It varies in its dimensions from a coating a line in thickness to masses 2 or more millimeters thick by 10 millimeters in length. Grains and flakes of troilite are occasionally contained in masses of the nickel-iron alloy and may then be associated with schreibersite areas. Further, it may occur as isolated grains or flakes and filling cracks in the olivine areas.

The material analyzed was obtained by treating the metallic portion with mercury bichloride, and after its solution separating the troilite and schreibersite from carbon, silicates, etc., with the magnet and from each other by lixiviation. The material thus obtained had a specific gravity of 4.759 at 18° C. and the following composition:

Iron.....	62.99
Nickel.....	} .79
Cobalt.....	
Phosphorus.....	Trace.
Sulphur.....	36.35

The specular material lining the olivine cavities is essentially a graphitic iron containing sulphur and chlorine. The material analyzed was far from being homogeneous, as it was separated mechanically with the aid of a glass. The composition was as follows:

Iron.....	84.900
Nickel.....	} 5.039
Cobalt.....	
Silica.....	2.990
Carbon.....	2.810
Sulphur.....	1.750
Phosphorus.....	1.470
Chlorine.....	.100
Alumina.....	.940

Chromite occurs quite abundantly, varying in size from microscopic grains to a crystal 1 millimeter in diameter. The crystals are more or less perfect octahedrons, rarely modified by other forms, and then only by α 0 (110), as noted in one instance. They are brilliant black

in color with a metallic luster; nonmagnetic; have a specific gravity of 4.49 at 18° C., with the following composition:

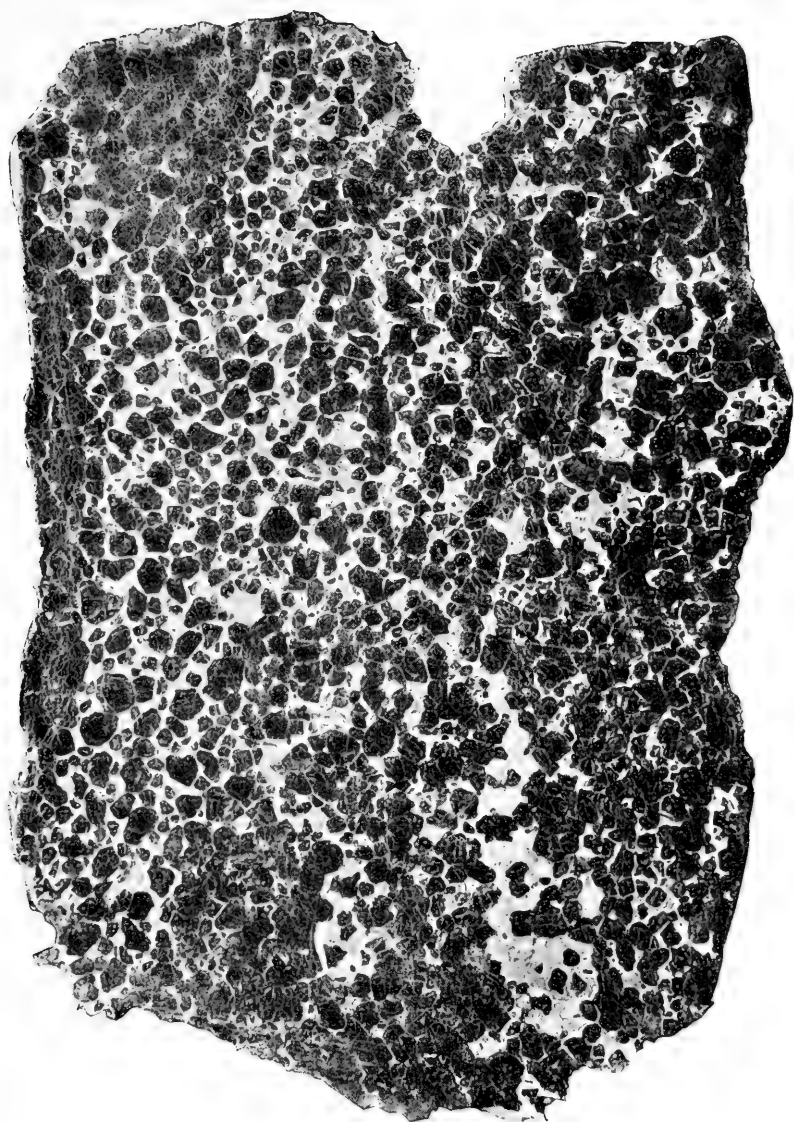
Chromic oxide	64.91
Alumina	9.85
Magnesia	4.96
Ferrous oxide	17.97
Silica	1.38

Olivine occurs in more or less rounded masses which, when carefully extracted, show well-marked facets. These facets are probably not to be referred to any crystal forms, since no zonal relations could be established after repeated measurements. The mineral is commonly brownish in color and only occasionally honey yellow. The blebs are more or less cracked and the cracks filled with foreign material, as graphitic iron, limonite, chromite, etc. Some of the clearest grains, which under the glass were quite free from impurities, were selected for analysis, with the following results:

Silica	35.70
Magnesia	42.02
Ferrous oxide	20.79
Ferric oxide .....	.18
Alumina .....	.42
Manganese .....	.14
Nickel oxide .....	.21
Phosphorus	Trace.



THE MOUNT VERNON PALLASITE.



THE MOUNT VERNON PALLASITE.

Cross section, showing structure.

THE SCORPÆNOID FISH, NEOSEBASTES ENTAVIS, AS THE TYPE OF A DISTINCT GENUS.

By THEODORE GILL,
Honorary Associate in Zoology.

The description and figure by Jordan and Starks of their *Neosebastes entavis*^a recalled the interest which the description of the typical *Neosebastes* aroused in me many years ago. I have consequently examined the newly added species, and the examination has convinced me of the aptness of the authors' suggestion that their species "may represent a new genus."

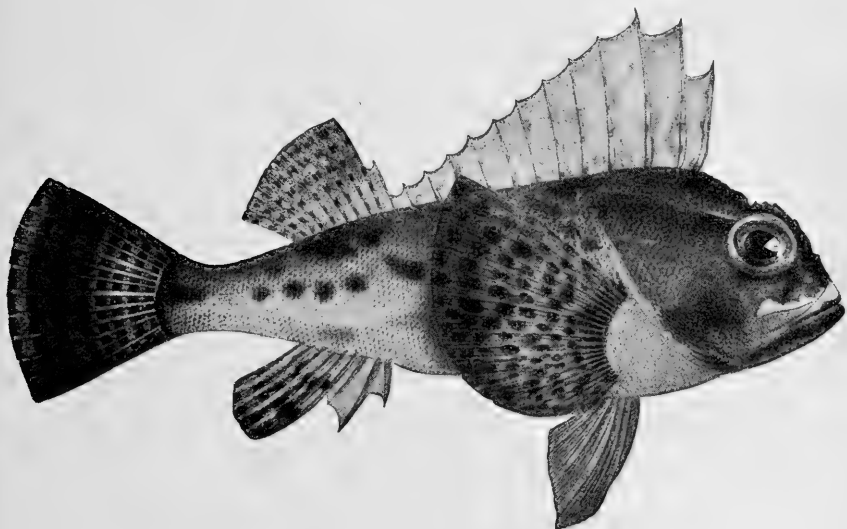


FIG. 1.—NEOSEBASTES SCORPÆNOIDES. (AFTER MCCOY.)

In most respects there is essential agreement between *N. scorpenoides* and *N. entavis*, but the latter does not possess those characters which were used to differentiate the genus. An excellent figure and description have been published by Sir F. McCoy,^b and they give the means of comparison between the two.

The *Neosebastes scorpenoides* has the body most convex near the nape, and the rest of the back nearly rectilinear tailwards; the pectoral fins have the "upper rays longest" and the "lower rays branched, the

^aProc. U. S. Nat. Mus., XXVII, 1904, p. 120.

^bNatural History of Victoria (pl. cxiii).

lower one nearly or quite simple;" the spinous part of the dorsal has the anterior spines slowly graduated (third longest), and the connecting membrane between all the rays is only slightly emarginated and not notched; the membrane between the anal spines is also merely notched.

The *Neosebastes entaxis* has the body most convex far behind the head and above the stomachal area, the back with only the last half rectilinear tailwards; the pectoral fins have rounded margins (the seventh and eighth rays being longest), and the lower ones (8) are unbranched; the spinous part of the dorsal has the first three spines rapidly graduated, and the connecting membrane between all is more or less deeply notched; the membrane behind the first and second anal spines is also deeply notched.

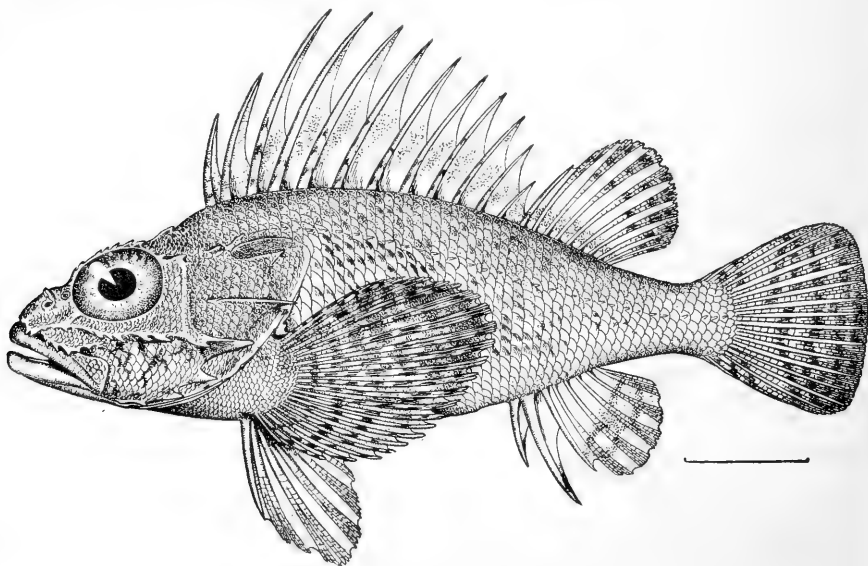


FIG. 2.—NEOSEBASTES ENTAXIS.

In fact, the difficulty of discrimination between the *N. entaxis* and its relatives is not so much between it and *N. scorpenoides* as between it and *Sebastes* and its near affines. From all such, however, the species is separated by characters which it shares with *N. scorpenoides* and which, indeed, led Jordan and Starks to refer it to the same genus: "Suborbital stay and preopercle with a row of strong hooked spines; dorsal spines very strong and long." The combination of all these characters, however, isolates the fish in question as the type of an independent genus.

The genus thus indicated may be named *Sebastosemus*, from *σεβαστος*, august, elevated, and *σῆμα*, battle banner, in allusion to the high ranked dorsal spines. The name is thus assimilated to many other genera of the family.

The only known species is the *Sebastosemus entaxis*.

NOTE ON THE GENERA OF SYNANCEINE AND PELORINE FISHES.

By THEODORE GILL,
Honorary Associate in Zoology.

For a long time I have been in doubt respecting the application of the name *Synanceia* and the consequent nomenclature of some other genera of the same group. Complication has resulted by reason of the intrusion of the incompetent Swainson into the field.

In 1801 Bloch and Schneider's name *Synanceja* was published (p. 194) with a definition, and the only species mentioned were named as follows:

1. HORRIDA	<i>Synanceia horrida.</i>
2. URANOSCOPA	<i>Trachicephalus uranoscopus.</i>
3. VERRUCOSA	<i>Synanceia verrucosa.</i>
4. DIDACTYLA	<i>Simopias didactylus.</i>
5. RUBICUNDA	<i>Simopias didactylus.</i>
6. PAPILLOSUS	<i>Scorpiæna cottoides.</i>

Two of the species having been withdrawn from the genus by Cuvier to form the genus *Pelor* (1817), and one to serve for the genus *Trachicephalus* (1839), the name *Synanceja* was thus restricted to the *horrida* and *verrucosa*.

In 1839 Swainson attempted to reclassify the Synanceines and named three genera, but on each of the three pages of his work (II, pp. 61, 180, 268) in which he treats of those fishes he has expressed different views.

On page 61 the names of Synanchia, Pelor, Erosa, Trichophasia, and Hemitripterus appear as "genera of the Synanchinæ" and analogues of five genera of "Scorpiæninæ."

On page 180 the following names are given under the head of Synanchinæ:

Agriopus.

Synanchia, with three subgenera, viz:

Synanchia.

Bufilethys.

Trachicephalus.

Trichodon.

On pages 267 and 268 another arrangement of the Synanchinae or "Hogfish" is given with quasi-definitions and designation of types, viz:

Agriopus.

Pelor.

Synanchia, with three subgenera, viz:

Synanchia (*erosa*)

Bufichthys (*horrida*).

Trachicephalus (*elongatus*).

Trichodon.

The definitions are, in a couple of cases, practically exchanged with those on former pages, so that the equivalents are as follows:

<i>P. 268.</i>	<i>P. 61.</i>	<i>Pp. 180, 181.</i>
Synanchia.	Erosa	Bufichthys.
Bufichthys.	Synanchia.	Synanchia.
Trachicephalus.	Trichophasia.	Trachicephalus.

Which has priority?

The mutations being published at the same time, it may justly be considered that we may have the right to accept the fullest expression of opinion as the determining one. Still more, the data on the previous pages are too meager and defective otherwise to determine what Swainson meant. It is only by comparison with the last exposition that we are able to ascertain what was intended by his former schemes. The preceding ones may be thus canceled, and the last is left to adopt or otherwise, as the history of the nomenclature may indicate.

In 1874 P. Bleeker published a "Révision des espèces insulindiennes de la famille des Synancéoides," in which he recognized four genera, exclusive of one not occurring in the region under consideration. The four corresponded essentially to the Swainsonian (pp. 267, 268), as follows:

<i>Bleeker.</i>	<i>Swainson.</i>
Pelor.	Pelor.
Synanceia.	Bufichthys.
Leptosynanceia.	
Polycanulus.	Trachicephalus.

The remaining genus was named *Synanchia* after Swainson, and its type was *S. erosa*.

In 1904 Jordan and Starks admitted four genera, having had no occasion to mention the others. The four may be thus correlated with genera admitted by Bleeker.

<i>Jordan and Starks.</i>	<i>Bleeker.</i>
Synanceia.	Synanceia.
Erosa.	Synanchia.
Pelor.	Pelor.
Inimicus. }	

The conclusions forced on the present writer agree essentially with those reached by Jordan and Starks. As indicated by them, "*Syn-*

anchia Swainson" was little more than "a mere misprint or vagary of spelling for *Synanceia*." It was, however, something more, for it was the form which the old Romans would have adopted if they had been called to latinize such a derivative from the Greek word *συνάγχη*. In fact, they did so in the form *synanche* or *cynanche*, the source of the English word quinsy. Therefore *Synanchia* was rather a proper correction of *Synanceia* than "a vagary of spelling." Nevertheless, as the original form *Synanceia* may be retained, and inasmuch as Swainson merely used *Synanchia* in place of *Synanceia*, Bleeker's usage was quite illegitimate. Such being the facts, the synonyms of the several genera apparently should be apportioned in the following manner:

SUBFAMILY SYNANCEINÆ.

Synanceinae KAUP, Archiv f. Naturg., 1873, I, p. 79.

Synanceinae GILL, Mem. Nat. Acad. Sci., VI, 1896, p. 135.

Synanceiinae JORDAN AND STARKS, Proc. U. S. Nat. Mus., XXVII, 1904, p. 93.

SYNANCEIA.

Synanceia BLOCHII Syst. Ich., Schneider ed., p. 194.

Synanceia CUVIER AND VALENCIENNES, Hist. Nat. Poiss., IV, 1829, p. 440.

Synanchia SWAINSON, Nat. Hist. Fish, etc., II, 1839, p. 180.

Bufilethys SWAINSON, Nat. Hist. Fish, etc., II, 1839, p. 268.

Synancidium MÜLLER, Abhandl. k. Akad. Berlin, 1844, p. 163.

Synanceichthys BLEEKER, Onz. Not. Ich. Ternate in Ned. T. Dierk, I, p. 234.

Synanceia BLEEKER, Rev. Synanceoides, 1874, p. 10.

The genera *Synanceia* and *Synancidium* have been separated solely on the ground that the former was supposed to have no vomerine teeth while the latter had some. Bleeker has expressly declared that the *S. horrida* sometimes has and sometimes has not vomerine teeth, and that such variation may occur in old as well as young; consequently the character has not even specific value and therefore the genera based on such a character are worthless. There are differences in the structure of the head which might justify generic separation but, according to Bleeker, the *S. platyrhynchus* is intermediate and nullifies the significance of such characters.

EROSA.

Erosa SWAINSON, Nat. Hist. Classif. Fishes, etc., II, 1839, p. 61.

Bufilethys SWAINSON, Nat. Hist. Classif. Fishes, etc., II, 1839, p. 180.

Synanchia SWAINSON, Nat. Hist. Classif. Fishes, etc., II, 1839, p. 268.

Synanchia BLEEKER, Rev. Synanceoides, p. 4, in Nat. Verh. Holl. Maatsch Wetensch., (3) II, No. 3, 1874.

Erosa JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVII, 1904, p. 156.

LEPTOSYNANCEIA.

Leptosynanceia BLEEKER, Rev. Synanceoïdes, 1874, p. 17.

A very distinct genus based on the *Synanceia astroblepa* of Richardson.^a

TRACHICEPHALUS.

Trachicephalus SWAINSON, Nat. Hist. Class. Fishes, etc., II, 1839, pp. 181, 268.

Trichophasia SWAINSON, Nat. Hist. Class. Fishes, etc., II, 1839, p. 61.

Polycaulus GÜNTHER, Cat. Fishes Brit. Mus., II, 1860.

Uranoblepus GILL, Cat. Fishes E. C. N. Am., 1861.

The name *Trachicephalus* was rejected and substitutes proposed at nearly the same time by Günther (late in 1860) and Gill (early in 1861) because of the similarity of *Trachicephalus* and *Trachycephalus*. The two, however, are etymologically distinct, the one referring to the rough head (*τραχὺς*, rough) and the other to the similarity of the head to that of a *Trachinus*, Swainson expressly declaring that "*Trachicephalus*" has the "shape and general aspect of *Trachinus*." In other terms, the two names are as distinct as *Macrocephalus* and *Microcephalus*, which have opposite meanings. *Trachicephalus* is therefore retained.

SUBFAMILY INIMICINÆ.

Pelorina GILL, Mem. Nat. Acad. Sci., VI, 1896, p. 135.

Pelorina JORDAN AND STARKS, Proc. U. S. Nat. Mus., XXVII, 1904, p. 93.

SIMOPIAS.

Les Synancees (*Synanceia*) §, CUVIER, Règne Animal, II, 1317, p. 286.

Les Pelors, CUVIER, Règne Animal, II, 1829, p. 168 (not "*Pelor*, Bonelli Mem. Acad. Tur., 1813").

The name *Pelor* can not be retained for this genus inasmuch as it had been appropriated, in 1813 by Bonelli, for a genus of caraboid beetles; this genus, though long regarded as a synonym of *Zabrus*, has been revived by Ganglbaur as a subgenus under *Zabrus*.

The name here proposed as a substitute is a compound of the Greek *σιμπος*, snub-nose, *οφ*, eye, with the suffix—*ιας*; allusion is made to the elevated supraorbital ridge and snout—the snubnosed high-orbited fish.

INIMICUS.

Inimicus JORDAN AND STARKS, Proc. U. S. Nat. Mus., XXVII, 1904, pp. 93, 158.

Pelor sp. AUCT.

This group, established at the expense of *Pelor* for those species with the upper pectoral rays not prolonged, as in the typical species, may be regarded as a mere subgenus of the old *Pelor*, and in that case should be considered as the generic name, while *Simopias* would follow as a subgeneric designation for *Pelor filamentosus*.

^a Zoology of the Voyage of the Sulphur, p. 69, pl. xxxix.

NOTE ON SCORPÆNA FRONDOSA.

Inasmuch as much emphasis has been laid on the peculiar elevation of the snout and orbits of the Pelors, it is in place to refer to a form originally described as *Scorpæna frondosa*,^a which has analogous characters. That species evidently does not belong to the genus *Scorpæna*, and may be isolated as the type of a new one to be named *Rhinopias*. It is well distinguished by the excavated crown and ele-



RHINOPIAS FRONDOSA. (AFTER GÜNTHER.)

vated nape and orbits, as well as by the elongated profile and upturned snout; the pectorals have narrower bases, the ventrals more advanced, and the vertical fins more elevated than in the typical *Scorpæna*. The *Rhinopias frondosa* of Mauritius is the only known species.

The figure accompanying the original description is here reproduced.

^a Günther, Proc. Zool. Soc., 1891, p. 483, pl. xxxix.

CAMBRIAN BRACHIOPODA WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

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The following genera and subgenera are referred to in this paper, either in describing them or in referring new species to them:

Protremata: *Billingsella*; *Billingsella* (*Otusia*); *Nisusia*; *Nisusia* (*Jamesella*); *Strophomena* (*Eostrophomena*); *Orthis* (*Plectorthis*); *Orthis* (*Orusia*); *Orthis* (*Finkenburgia*); *Protorthis*; *Protorthis* (*Loperia*); *Syntrophia*; *Polytaechia*; *Swantonina*.

Neotremata: *Obolella*; *Acrotreta*; *Acrothyra*; *Acrothele*.

Atremata: *Iphidella*; *Kutorgina*; *Rustella*; *Dicellogmus*; *Urticea*; *Quebecia*; *Elkania*; *Schuchertina*; *Obolus*; *Obolus* (*Lingulella*); *Obolus* (*Lingulepis*); *Obolus* (*Westonia*).

This is the sixth paper resulting from the preliminary studies for the monograph on the Cambrian Brachiopoda. These notes,^a like those that have preceded, are published in the hope that they may be of service to students prior to the appearance of the monograph.

Genus BILLINGSSELLA Hall and Clarke.

1857. *Orthis* BILLINGS, Report Geological Survey of Canada, p. 297.

1860. *Orthis* SHUMARD, Trans. St. Louis Acad. Sci., I, p. 627.

^a Note on the genus *Lingulepis*, Amer. Jour. Sci., 4th ser., III, 1897, pp. 404, 405.

Cambrian Brachiopoda: Genera *Iphidea* and *Yorkia*, with descriptions of new species of each, and of the genus *Acrothele*, Proc. U. S. Nat. Mus., XIX, 1897, pp. 707-718.

Note on the brachiopod fauna of the quartzitic pebbles of the Carboniferous conglomerates of the Narragansett Basin, Rhode Island, Amer. Jour. Sci., 4th ser., VI, 1898, pp. 327, 328.

Cambrian Brachiopoda: *Obolus* and *Lingulella*, with descriptions of new species, Proc. U. S. Nat. Mus., XXI, 1898, pp. 385-420.

Cambrian Brachiopoda: *Obolella*, subgenus *Glyptias*; *Bicia*; *Obolus*, subgenus *Westonia*; with descriptions of new species, Proc. U. S. Nat. Mus., XXIII, 1901, pp. 669-695.

Cambrian Brachiopoda: *Acrotreta*; *Linnarssonella*; *Obolus*; with descriptions of new species, Proc. U. S. Nat. Mus., XXV, 1902, pp. 577-612.

1861. *Orthisina* BILLINGS, Geology of Vermont, II, p. 949, figs. 350-352.
 1861. *Orthisina* BILLINGS, Paleozoic Fossils, I, p. 10, figs. 11, 12.
 1862. *Orthisina* BILLINGS, Paleozoic Fossils, I, p. 138, fig. 115.
 1863. *Orthis* HALL, 16th Rept. N. Y. State Cab. Nat. Hist., p. 134, pl. vi, figs. 23-27.
 1863. *Orthisina* BILLINGS, Geology of Canada, p. 284, fig. 289.
 1867. *Orthisina* HALL, Trans. Albany Institute, V, p. 113.
 1868. *Orthis* HARTT, Dawson's Acadian Geology, Second Edition, p. 644, fig. 233.
 1882. *Orthis* WHITFIELD, Geology of Wisconsin, IV, p. 170, pl. I, figs. 4, 5.
 1883. *Orthis* (*Orthisina*?) HALL, Report of State Geologist, N. Y., pl. XXXVII, figs. 16-19.
 1884. *Orthisina* WHITFIELD, Bull. Am. Mus. Nat. Hist., I, p. 144, pl. xiv, fig. 6.
 1884. *Orthis* WALCOTT, Bull. No. 10, U. S. Geol. Survey, p. 17, pl. I, figs. 1, 1a-d.
 ?1884. *Orthis* WALCOTT, Mongr. U. S. Geol. Survey, VIII, p. 22, pl. IX, figs. 8, 8a.
 1886. *Orthisina* WALCOTT, Bull. No. 30, U. S. Geol. Survey, pp. 120-122, pl. VII, figs. 5-7.
 1886. *Orthis* MATTHEW, Trans. Roy. Soc. of Canada, Sec. IV, p. 43, pl. v, figs. 20a-c; (?) p. 42, pl. v, figs. 18a-c.
 1892. *Billingsella* HALL and CLARKE, Pal. New York, VIII, Pt. 1, p. 230.
 1896. *Orthis* (*Billingsella*) SARDESON, Bull. Minnesota Acad. Nat. Sci., IV, p. 96.
 1897. *Billingsella* SCHUCHERT, Bull. U. S. Geol. Survey, No. 87, p. 158.

Diagnosis.—Shell subquadrate or subsemicircular in outline. Contour unequally biconvex or plano-convex. Shell punctate. (?) Surface striate or plicate. Ventral valve with the greatest convexity; cardinal area moderately high, slightly inclined outward; delthyrium covered by a convex plate which in the type species *B. coloradoensis* has a minute perforation near the apex; teeth well developed, with dental plates extending to the bottom of the umbonal cavity and forming the sides of a small area opposite the delthyrium, where the pedicle muscle was probably attached. In the dorsal valve the cardinal area is strongly inclined, but less than 90° to the plane of the valve. The delthyrium is partially covered by a convex chilidium, or it may be altogether absent. Cardinal process single.

Type.—*Orthis coloradoensis* Shumard.

Observations.—Messrs. Hall and Clarke founded the genus on *Orthis pepina* Hall, which is a synonym of *Orthis coloradoensis* Shumard. The material from the limestones of Texas in the collections of the Survey show the form of the teeth in the ventral valve, also the deltidium and the minute perforation near its apex. Messrs. Hall and Clarke state in their diagnosis that "in rare instances [it] may be minutely perforated at the apex," but do not name the species in which the perforation occurs or where the specimens showing it are to be found. All the species known to me are biconvex or plano-convex; none are concavo-convex as defined by Messrs. Hall and Clarke.

The genus is essentially orthoid, but it differs in the presence of the areched deltidium and its general aspect.

The species may be grouped on surface characters into four sections as follows:

1. Costate:

- B. ? appalachia.*
B. coloradoensis.
B. dice.
B. exporrecta.
B. hicksi.
B. lindstromi.
B. major.
B. obscura.
B. orientalis.
B. pumpellyi.
B. richthofeni.
B. romingeri.
B. striata.

2. Smooth costate:

- B. plicatella.*

3. Smooth striate:

- B. highlandensis.*

4. Smooth:

- B. ? anomala.*
B. harlanensis.
B. saffordi.
B. salemensis.
B. whitfieldi.

Of the species referred to the genus, *Billingsella exporrecta* is one that departs from the typical species in the absence of a convex deltidium; whether this is owing to the absence of a deltidium originally or to its accidental removal from the specimens studied, is undecided.

The species referred to *Billingsella* are:

Name.	Cambrian.			Ord.
	L.	M.	U.	
1. <i>? anomala</i> , new species		X		
2. <i>? appalachia</i> , new species			X	
3. <i>coloradoensis</i> Shumard		X	X	
4. <i>dice</i> , new species				X
5. <i>exporrecta</i>		X		
6. <i>exporrecta</i> var. <i>rugosicostata</i> , new variety		X		
7. <i>harlanensis</i> , new species		X		
8. <i>hicksi</i> (Salter) Davidson		X		
9. <i>highlandensis</i> Walcott		X		
10. <i>lindstromi</i> Linnarsson		X		
11. <i>major</i> , new species			X	
12. <i>obscura</i> , new species		X		
13. <i>orientalis</i> Whitfield	X			
14. <i>plicatella</i> , new species			X	
15. <i>pumpellyi</i> , new species		X		
16. <i>richthofeni</i> , new species		X		
17. <i>romingeri</i> Barr. (Sp.)		X		
18. <i>saffordi</i> , new species		X		
19. <i>salemensis</i> Walcott	X			
20. <i>striata</i> , new species		X		
21. <i>whitfieldi</i> Walcott	X			
<i>Otusia</i> , new subgenus of <i>Billingsella</i> .				
1. (<i>Otusia</i>) <i>sandbergi</i> Winchell			X	

BILLINGSSELLA ? ANOMALA, new species.

Shell subquadrilateral, with the dorsal valve transverse. On the ventral valve the cardinal line slopes toward the beak at an angle of from 15° to 20° , while in the dorsal valve it is nearly straight. The greatest width of the valves is about the middle of the shell. Owing to compression and consequent distortion there is considerable variation in the relative proportions of length and breadth. The cardinal angle is acute, in some instances extending out some distance beyond the widest portion of the shell, resembling in this respect the cardinal angles of some of the Strombomenidæ. All of the specimens are so compressed in the shale that little is preserved of their natural convexity. A low, broad, mesial sinus occurs on the dorsal valve, and there is a slight flattening of the anterior central portion of the ventral valve.

The surface is marked by fine, radiating striæ that are increased in number toward the front by the addition of interstitial striæ, giving a fasciculate appearance to the surface. The radiating striæ are crossed by concentric lines of growth and fine striæ. The surface as described occurs in one specimen, all other specimens being nearly smooth. This, however, may arise from maceration and flattening out of the surface characters by compression. The interior of the shell appears to have been covered by minute punctæ.

The largest specimen of the collection has a transverse diameter of 14 mm. The average size of the ventral valve is about 8 mm. in height by 8 mm. in width.

Cardinal area about one-fifth the height of the shell. It is marked by transverse striæ of growth that cross it parallel to its base. Delthyrium rather broad. No traces of the deltidium have been observed. Cardinal area of the dorsal valve short. It is divided midway by a strong delthyrium. Nothing is known of the interior characters except the presence of short crura in the dorsal valve.

Observations.—This shell occurs quite abundantly in the very fine, buff-colored, argillaceous shales of the Coosa Valley Cambrian section. There is doubt as to its surface characters, as only one specimen found in the same beds has radiating striæ. All others appear to be nearly smooth. Its strongest character is the extension of the cardinal angle. Owing to the imperfection of the material the generic reference is doubtful.

Formation and locality.—Middle Cambrian, Coosa Valley shales. Cowan Creek section. Edwards farm, near Craigs Mountain, Cherokee County, Alabama.

BILLINGSSELLA? APPALACHIA, new species.

The outline of the dorsal valve is rounded subquadrate. The height and width of the ventral valve are about the same. Dorsal valve slightly transverse.

The surface is marked by round, very fine, radiating costæ, and lines of growth, with very fine interstitial concentric striæ.

The average size of the ventral valve is about 10 mm. in height with an equal width. The largest shell observed was a ventral valve with a width of 14 mm.

Cardinal area of the ventral valve rather low. It is divided midway by a rather strong delthyrium.

Observations.—This shell in form and size is much like that of *B? anomala*. It differs in strongly marked surface characters. All the specimens are flattened in the shale by compression, and nothing is known of the interior characters.

Formation and locality.—Upper Cambrian. Rogersville shales. Four miles northeast of Rogersville, on roadside just east of Harlan's Knob, Tennessee.

BILLINGSSELLA COLORADOENSIS Shumard.

Orthis coloradoensis SHUMARD, Trans. St. Louis Acad. Sci., I, 1860, p. 627.

Orthis pepina HALL, 16th Rept. N. Y. State Cab. Nat. Hist., 1863, p. 134, pl. vi, figs. 23-27.

Orthis pepina HALL, Trans. Albany Institute, V, 1867, p. 113.

Orthis pepina WHITFIELD, Geol. Wisconsin, IV, 1882, p. 170, pl. i, figs. 4, 5.

Orthis? (*Orthisina?*) *pepina* HALL, 2d Ann. Rpt. N. Y. State Geologist, 1883, pl. XXXVII, figs. 16-19.

Billingsella pepina HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, pl. VII, figs. 18-19; pl. VIIA, figs. 7-9.

Orthis (*Billingsella*) *pepina* SARDESON, Bull. Minnesota Acad. Nat. Sci., IV, 1896, p. 96.

Billingsella coloradoensis SCHUCHERT, Bull. U. S. Geol. Sur., No. 87, 1897, p. 158.

Billingsella coloradoensis WALCOTT, Mongr. XXXII, U. S. Geol. Survey, Pt. 2, 1899, p. 450, pl. LXI, figs. 1, 1 a-d.

Shell usually transverse, but in many examples the ventral valve is longer than wide. The general outline is irregularly subquadrate to subsemicircular. On the ventral valve the hinge line slopes toward the beak at a low angle, while in the dorsal valve it is nearly straight. In some individuals the greatest width is at the hinge line. In others it is at about the middle. There is considerable variation in the relative proportions of length and breadth.

The ventral valve is slightly more convex than the dorsal. The degree of convexity of the two valves varies considerably in specimens from different localities. Some of the ventral valves from the Hudson beds at Franconia, Minnesota and the young shells from Trempealeau, Wisconsin are strongly convex.

A low, broad, mesial sinus occurs on nearly all specimens of the dorsal valve, being strongest in the young shells, and occasionally a shallow sinus is clearly defined on the ventral valve. It is quite rare to find a well-marked median fold on the ventral valve.

The surface is marked by sharply rounded, fine, radiating costæ, crossed by fine, concentric lines of growth, and very fine, slightly undulating concentric striæ. The size and sharpness of the radiating costæ vary greatly in specimens from the same bed at the typical locality in Texas. Shells occur with strong, rounded costæ, and no traces of fine, elevated lines between, while others show from one to four or more lines that start at varying distances from the beak. The imbricating lines of growth give a concentrically ridged aspect to some shells, while others are nearly smooth from beak to frontal margin. The increase in the number of costæ is by interpolation, not by bifurcation.

There is considerable variation in the size of the shell. The largest specimens from Texas have a transverse diameter of 19 mm., with a height of 14 mm. for the dorsal valve, and about 18 mm. for the ventral valve. Specimens of the ventral valve from the Yellowstone National Park have a height of 14 mm. with a width of 15 mm.

Cardinal area of ventral valve moderately high. It is marked by transverse striæ of growth that cross it parallel to its base and arch over the convex deltidium. The plane of the area extends backward at an angle of about 10° to the plane of the margin of the shell. The delthyrium is strong and covered by a convex deltidium, the front margin of which arches back about one-fifth the length of the delthyrium; the deltidium is marked by concentric striæ of growth and fine radiating lines and a minute perforation near its apex. The cardinal area of the dorsal valve is short as compared with the ventral valve. It extends backward at an angle of about 45° to the plane of the margin of the valve. It is divided midway by a strong delthyrium, which is covered about half its distance by a convex chilidium.

In the interior of the ventral valve the hinge teeth appear to be supported by dental plates that extend down to the bottom of the valve and bound the tripartite umbonal space opposite the delthyrium, into which the vascular sinuses extend on each side of the diductor muscle impressions, or their path of advance. The traces of the vascular system are confined to the main vascular trunks, which extend forward nearly to the front margin, where in some examples they are bifurcated. The inner branch extends in toward the median line, disappearing in the numerous radiating depressions near the margin. The lateral branches appear to connect with the peripheral canal that arches about the space, probably occupied by the ovarian areas, between itself and the main vascular trunks. The spaces for the attachment of the muscles between the main vascular trunks appear to have been

quite large, extending forward to the anterior fifth of the length of the valve, but no subdivisions indicating the points of attachment of the different muscles have been detected. The pedicle muscles were probably attached to the elevated posterior portion of this central area. In some casts this posterior area is scarcely elevated above the plane of the interior. In others it is quite prominent.

In the interior of the dorsal valve the interior of the deltidial cavity supports a small, well-developed cardinal process or callosity, and a slight, narrow, median ridge occurs just in advance of the deltidial cavity. The crura are short and well defined, with relatively shallow dental sockets beside them. The cardinal process and crura vary in size and length in shells from the same locality. The only traces of the muscle scars observed show the anterior adductor impressions. The vascular trunks of the dorsal valve diverge from the central line about the center of the shell after passing around the adductor muscle impressions.

Observations.—The average size of the typical specimens from Texas is from 10 to 14 mm. in height for the ventral valve, the width being about the same. At one locality on Morgan's Creek several dorsal valves were found that have a width of 18 mm., with a height of 12 mm. This may possibly indicate a variety or distinct species, but with the material in the collection it is impossible to determine it definitely. The shells from the upper Mississippi Valley in Wisconsin and Minnesota average about the same size as the typical forms from Texas. The young shells are much more convex. The material from the Gallatin Range, Yellowstone National Park, is also much like that from Texas, but that from the limestone near Malad City, Idaho, while containing typical shells, also has specimens as large as those from Morgan's Creek, Texas.

Billingsella major differs from *B. coloradoensis* in the character of the surface striation, also in its larger size. *B. plicatella* is a uniformly smaller and more convex shell, and also has distinct surface characters. The same is true of *B. striata*.

This species has a wide geographic range that extends from Texas to Missouri, Minnesota, and Wisconsin, and westward into Montana, Wyoming, and Idaho. Its vertical range in Texas is limited to the upper portion of the Middle Cambrian, and in Wisconsin and Minnesota to the St. Croix sandstone from the upper portion of the zone of the Middle Cambrian horizon nearly through the zone of the Upper Cambrian fauna; in Idaho to the Middle Cambrian; in the upper Gallatin Valley of Wyoming to the Upper Cambrian; and probably the same horizon in the Gallatin Valley below in Montana. There does not appear to be any specific variation in the shells from Texas, the upper Mississippi Valley, and the Upper Cambrian of Wyoming.

Formation and locality.—Middle and Upper Cambrian.

In Texas abundant in the limestones of the Middle Cambrian, at Packsaddle Mountain, Llano County; at Morgan's Creek, Honey Creek, and Coal Creek Canyon in Burnett County.

In Wisconsin, Middle Cambrian at Trempealeau, below the fifth trilobite bed; also in the uppermost horizon of the Upper Cambrian at that locality; Middle Cambrian zone at Hudson, at bluff near city and 4 miles from Readsburg; Osceola Mills quarry in suburbs of village near St. Croix River; Berlin; Winona; Alma; and Menominee.

In Minnesota, 4 miles southeast of Lake City; River Junction, Houston, 20 miles below Dresbach; Red Wing; Reads Landing, foot of Lake Pepin; Minneiska.

In Missouri, casts of this shell occur in the thin-bedded magnesian limestones 50 feet above the conglomerate series in St. Francois County, collected by Dr. Frank Nason; at about the same horizon in Iron County, in sec. 22, T. 35, R. 1 E., collected by Mr. D. K. Gregor.

In Montana, Spring Hill Canyon, west side of Bridger Range; east and west sides of Dry Creek above Pass Creek, Gallatin Valley; north and east Gallatin River, near Hillsdale.

In Idaho, Gallatin limestone 3 miles southeast of Malad City; also, 2 miles southeast of Malad City in limestone resting on the Flathead sandstones.

In Wyoming, Gallatin limestone on the divide at the head of Sheep Creek, Teton Range; Crowfoot section, Gallatin Range; also on the north slope of the Crowfoot Ridge on the south side of the Gallatin Valley, and on the divide between Panther Creek and the Gallatin River.

As far as known the species occurs in association with the Middle Cambrian fauna in Texas, Wisconsin, Minnesota, and Idaho. In the Teton and Gallatin Ranges, Wyoming, however, it occurs at the upper limit of the Cambrian.

BILLINGSSELLA DICE, new species.

In general form and surface this shell is related to *B. romingeri*. It differs from the latter in its strong dental plates.

Formation and locality.—Lower Ordovician (?) The specimens of this shell are from a drift boulder found near St. Albans, Vermont. The lithological characters of the matrix point to the arenaceous limestones of the Phillipsburgh formation just north of the United States and Canadian boundary as the source of the boulder.

BILLINGSSELLA EXPORRECTA Linnarsson.

Orthis exporrecta LINNARSSON, Bihang till K. Svenska Vet. Acad. Handlingar, III, 1876, No. 12; Brach. Paradoxides Beds of Sweden, p. 12, pl. II, figs. 13-19; pl. III, figs. 20, 21.

Orthis exporrecta KAYSER, Cambrische Brach. von Lian Tung, China, Riechthofen, IV, 1893, p. 35.

Shell transversely subsemicircular; with the hinge line usually a little shorter than the greatest width. In a few examples it is a trifle longer; the cardinal angles are obtusely angular. The proportions between the length and breadth vary. The ventral valve is considerably more convex than the dorsal. It is evenly rounded while the dorsal valve usually has a flattening of the median area, and sometimes a slight, broad sinus. The surface is marked by numerous radiating costæ and very fine concentric striæ between the costæ, and a few visible lines of growth. The costæ are rounded, usually, but not always, broader than the interspaces and continuous from the umbo to the front and lateral margins; they appear to be quite regular, although varying much in size, and increasing somewhat irregularly by interpolation of new costæ; this usually occurs near the umbo, but may occur near the middle of the valve. The largest ventral valve in the collection has a length of 9 mm. and breadth of 11 mm. Dorsal valve, length 7 mm., breadth 10 mm. Cardinal area of ventral valve high and overhanging the posterior margin. The delthyrium is large and appears to have just a trace of a deltidium about its sides. Cardinal area of dorsal valve short and slightly inclined forward; it is divided midway by a broad delthyrium, which is divided by a strong cardinal process.

In the interior of the ventral valve, strong, main, vascular sinuses extend well forward toward the front margin; the cast of the umbonal cavity opposite the delthyrium shows a tripartite division, the center of which is the area of the path of advance of the diductor muscle impressions, and those on each side appear to be the posterior portion of the main vascular sinuses. The anterior edge of the cavity is marked by a sharp, elevated, forward arching ridge that extends to the teeth on either side; the dental plates appear to have extended to the bottom of the valve, and to have bounded the sides of the triangular umbonal cavity opposite the delthyrium.

The interiors of the dorsal valves are beautifully preserved. The cardinal process, crura, crural plates, area, anterior and posterior adductor muscle scars and vascular sinuses are very distinct; the dental sockets are shallow, but clearly shown. In one specimen there appear to be two lateral supporting septa to the thickening before the crural plates that bound the spaces occupied by the point of attachment of the diductor muscles. Doctor Linnarsson describes the cardinal process as triangular. I find it both straight, subtriangular, and triangular. A short median septum is shown in some shells, but usually the strong, slightly rounded, flattened, median ridge does not carry it.

Observations.—This is one of the most variable species of the genus both in external, and, as far as known, internal characters. It is very abundant but interiors of the ventral valve are rarely met with in good condition.

Doctor Linnarsson compares *O. exporrecta* with *Orthis hicksi* which appeared to be the most nearly related, pointing out that it differed in having fewer and coarser ribs, less pointed beak and lower area.

Formation and locality.—Middle Cambrian. Zone of *Paradoxides forchhammeri*. Linnarsson's localities are Kinnekulle, Lovened and Gudhem in Westrogothia; also at several places in Nesike; at Södra Möckleby in Öland; and in loose stones at Lillviken in Jemtland. In strata with *Agnostus lacrigatus* at Carlsfors in Westrogothia, Sweden.

The specimens I have illustrated were collected by M. Schmalensee in Westrogothia.

BILLINGSSELLA EXPORRECTA, var. RUGOSICOSTATA, new variety.

Orthis hicksi LINNARSSON, Bihang till K. Svenska Vet. Acad. Handlingar, III, 1876, No 12; Brach. Paradoxides Beds of Sweden, p. 13, pl. III, figs. 22, 23.

Doctor Linnarsson recognized that this shell was not the same as his *Orthis exporrecta* and placed it provisionally under *Orthis hicksi*, calling attention to the fact that it was nearly related to *O. exporrecta*. With a fine series of specimens for comparison I place the shell as a variety of *B. exporrecta*. It is characterized by its strong irregular costæ. Doctor Linnarsson indicated as the most important differences; "ventral valve less convex; cast of diductor muscle scars less distinct; dorsal valve more convex and muscle scars more strongly marked; radiating ribs in the casts fewer, stronger, and more angular." All of the differences exist when we compare the extreme forms, but with a good series of specimens most of them pass gradually into forms that are typical of *B. exporrecta*.

Formation and locality.—Middle Cambrian. Zone of *Paradoxides forchhammeri*. Doctor Linnarsson found this shell at Kinnekulle and Lovened in Westrogothia and at Södra Möckleby in the island of Öland, Sweden. The specimens I have illustrated were collected by M. Schmalensee in Westrogothia.

BILLINGSSELLA HARLANENSIS, new species.

The general form and convexity of this shell is similar to that of *B. plicatella*. It differs in having a nearly smooth surface marked only by fine concentric striae and a few traces of sharp radiating costæ. The interior of the ventral valve has very strong main vascular sinuses and a deep, sharply defined, tripartite umboral area opposite the delthyrium; the tripartite area is much like that in *B. coloradoensis* and *B. exporrecta*. The main vascular sinuses pass directly back across the ridge in front of the tripartite area and occupy the two lateral divisions of the area. The interior of a dorsal valve, shows an abnormal arrangement of the vascular markings and muscle scars.

Formation and locality.—Middle Cambrian. Limestone layers in Rogersville shale, 4 miles northeast of Rogersville and 11 miles northwest of Knoxville, Tennessee.

BILLINGSSELLA HICKSI (~~Salter~~) (Davidson.)

Orthis hicksi (Salter MS.) DAVIDSON, Geol. Mag., V, 1868, p. 314, pl. xvi, figs. 17-19.

Orthis hicksi DAVIDSON, Brit. Foss. Brach., III, 1871, p. 230, pl. xxxiii, figs. 13-16.

Orthis hicksi KAYSER, Cambrische Brach. v. Lian Tung, China, Richthofen, IV, 1893, p. 35.

Original description.—Shell small, transversely oval; hinge-line shorter than the greatest breadth of the shell; cardinal angles rounded. Dorsal valve semicircular, moderately convex, slightly longitudinally depressed along the middle. Ventral valve convex, deeper than the opposite one. Area triangular, moderately wide; surface of valves ornamented by about ten principal, narrow, radiating ribs, with wide interspaces between each pair, in the middle of which is situated a shorter rib.

Length about 4, width 5 lines.

Obs.—*Orthis hicksi* is a scarce fossil, and very rarely found, even in a passably complete condition. It was discovered by Mr. Hicks in the middle (sandstone) beds of the Menevian group at Ninewells and Porth-y-rhaw, near St. Davids, and is the oldest species of the genus on record. It has not been hitherto found in North Wales, nor, to my knowledge, in any other locality.

This shell is most nearly related to *B. exporrecta*. It differs in its more rounded form, fewer radiating ribs and muscle area of ventral valve.

Formation and locality.—Middle Cambrian. Menevian sandstone, as stated above.

BILLINGSSELLA HIGHLANDENSIS Walcott.

Orthis ? highlandensis WALCOTT, Bull. U. S. Geol. Sur. No. 30, 1886, p. 119, pl. viii, figs. 3, 3a, 3b.

Orthis highlandensis WALCOTT, Tenth Ann. Rept. U. S. Geol. Sur., 1891, p. 612, pl. lxxii, figs. 5, 5a, 5b.

Shell transversely oval or subrotund. Front broadly rounded and nearly straight in the dorsal valve. On the ventral valve the cardinal line slopes toward the beak at an angle of about 20° , while in the dorsal valve it is less than 10° . The greatest width is about the middle of the shell. The ventral valve is moderately convex, being most elevated toward the beak, which is slightly arched over to the cardinal margin.

A dorsal valve associated in the same hand specimen of limestone is more convex than the ventral valve. The cardinal line is shorter at the greatest width of the shell. The median fold is but slightly raised above the general surface, although the front margin has a low, broad arch for the reception of the fold of the ventral valve.

There is a slight flattening in the central portion of the ventral valve that in some specimens forms a low, broad, mesial sinus toward the front margin.

The surface is marked by concentric lines of growth; otherwise it appears to be smooth. Interior casts of the valves show fine, radiat-

ing striae toward the front. In a number of partially exfoliated shells the shell is shown to be thick and apparently solid, having been replaced by calcite.

The average sized ventral valve has a height of 13 mm. with a width of 16 mm. One dorsal valve is 17 mm. in width.

Cardinal area of the ventral valve unknown except that its plane extends backward at an angle of about 10° or 15° to the plane of the margin of the shell.

Casts of the interior of the ventral valve show that the dental plates extend down to the bottom of the valve, supporting distinctly defined hinge teeth. The traces of a vascular system are limited to the main vascular trunks, which extend forward well toward the front margin, very much as in *B. coloradoensis*. In one cast there is a strong furrow extending from a median furrow obliquely outward to each main vascular sinus. The median furrow extends backward to the apex of the cast that filled the space beneath the umbo and the deltidium. This portion of the cast is also marked by fine vertical venation. In another cast there is a very narrow median furrow. These median furrows probably indicate the beginning of a septum that in later forms connected the deltidium with the shell. Nothing is known of the interior of the dorsal valve.

Observations.—The original description of this species was based upon material from which the preceding description is taken, also a specimen now referred to another species in which the area is nearly perpendicular.

This species is strongly characterized by its nearly smooth surface, in having the dorsal valve more convex than the ventral, and the presence in the ventral valve of a sharp ridge beneath the umbo, indicating the beginning of the growth of a median septum.

Formation and locality.—Middle Cambrian. In the limestone with *Olenellus gilberti*, *Olenoides levis*, etc., at Pioche, and also on the west side of the Highland Range, 11 miles north of Bennett's Springs, and at the south end of the Timpahute Range, Groome District, Nevada.

BILLINGSSELLA LINDSTROMI Linnarsson.

Orthis lindstromi LINNARSSON, Bihang till K. Svenska Vet. Acad. Handlingar, III, 1876, No. 12; Brach. Paradoxides Beds of Sweden, p. 10, pl. 1, figs. 1-8; pl. II, figs. 9-12.

The general description of *B. coloradoensis* applies to this species. The casts of the interior have the same general flatness of appearance and the exterior surfaces are not unlike. In detail the two differ materially. The radiating costae of *B. lindstromi* are usually stronger; the umbo of the ventral valve is more prominent and the beak more incurved. The interior of the ventral valve shows shorter main vascular sinuses and more limited ovarian areas.

Doctor Linnarsson gives a fine series of illustrations of the interior of the ventral valve, which shows that there is considerable variation in the position of the vascular markings. He states that the small cardinal process appears to be bifid. I find it single in a natural cast in the limestone from Alunbruk. There is also a narrow median septum as in the dorsal valve of *B. coloradoensis*.

Doctor Linnarsson writes:

I do not know any species with which this can be confounded. At least the adult specimens are always easily recognized. In the young ones the characters are less marked, especially in the dorsal valves. The interior and the internal cast of the ventral valve is in all stages of growth easily recognized.

Formation and locality.—Middle Cambrian. Zone of *Paradoxides forchhammeri*. Kinnekulle and Lovened in Westrogothia, Island of Öland, at Södra Möckleby and Alanbruk, Sweden. Doctor Linnarsson also found it in loose stones at Lillviken Jemtland. The specimens I have illustrated were collected by M. Schmalensee at Alanbruk.

BILLINGSSELLA MAJOR, new species.

In general form and convexity this shell is related to *B. coloradoensis*. It differs from it in being larger and in having coarser radiating ribs. It is the Upper Cambrian representative of the latter species.

Formation and locality.—Upper Cambrian. Fine grained, buff colored sandstone in excavation on Wells' farm, 2 miles west of Baraboo, Wisconsin.

BILLINGSSELLA OBSCURA, new species.

This species is founded on a single dorsal valve that occurs in the form of a cast in sandstone. It is transverse, width 18 mm., height 13 mm.; moderately convex with a slightly defined mesial flattening that broadens out nearly to three-fifths the width of the shell at the front margin. The surface of the cast is marked by a few faintly defined, rather broad costæ.

The shell is much like the large dorsal valves of *B. coloradoensis*. It differs in its broader frontal margin and median flattening.

Formation and locality.—Middle Cambrian. Thin bedded sandstones just above the massive Tonto sandstone near the head of Nunkoweap Valley, Grand Canyon of the Colorado, Arizona.

BILLINGSSELLA ORIENTALIS Whitfield.

Orthisina orientalis WHITFIELD, Bull. Amer. Mus. Nat. Hist., I, 1884, p. 144, pl. xiv, fig. 6.

Orthisina orientalis WALCOTT, Bull. U. S. Geol. Sur., No. 30, 1886, p. 120, pl. vii, fig. 6; Tenth Ann. Rept. U. S. Geol. Sur., 1891, p. 613, pl. lxxii, fig. 8.

Billingsella orientalis HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, p. 230.

Original description.—Shell quadrangular in outline, somewhat higher than wide, with vertical and subparallel lateral margins and broadly rounded base. Cardinal

line rapidly sloping from the apex to the extremities, which are slightly rounded. Hinge line straight, as long as the greatest width of the shell. Cardinal area broad and high, divided in the middle by a triangular foramen, which is about as high as wide. Surface of the ventral valve moderately convex, marked by very fine radiating striae and also by several concentric lines of growth. Filling of the rostral cavity and foramen large and prominent. Specimen, a cast in shale, of the ventral valve only.

Observations.—The type specimen as described above is flattened in the shale, and also appears to be compressed laterally. Uncompressed specimens referred to this species from the siliceous limestones east of Swanton show the ventral valve to have been rather strongly convex, and the dorsal valve moderately so. The outer surface as shown in the cast, indicates that it was somewhat like that of *B. coloradoensis*, but that it differs in having finer and more numerous thread-like costae. A few traces of concentric striae and lines of growth are preserved. The material is very unsatisfactory, but it is sufficient to indicate that the genus occurs in association with *Olenellus thompsoni* in the upper beds of the Lower Cambrian section.

Formation and locality.—Lower Cambrian. Georgia terrane. Silico-argillaceous shales; Parker's quarry, town of Georgia; and in a gray siliceous limestone lentile, 2 miles east of Swanton, Vermont.

BILLINGSSELLA PLICATELLA, new species.

Shell irregularly subquadrate in outline. In the ventral valve the cardinal line slopes toward the beak at an angle of from 5° to 10° , while in the dorsal valve it is usually about 1° to 3° . The greatest width of the shell is about the middle. There is some variation in the relative proportions of length and breadth. Usually, however, the ventral valve is fully as high as wide, while in the dorsal valve it is slightly transverse. The ventral valve is rather strongly convex, the dorsal valve being less so. A low, broad, mesial sinus occurs on nearly all specimens of the dorsal valve, and sometimes a distinct sinus on the ventral valve.

The surface is marked by costae that gives it a plicated appearance in many specimens; also concentric lines of growth and very fine, slightly undulating striae. On some shells the costae and surface markings have been almost entirely removed by abrasion, while in others they are clear and distinct. There is quite a wide range of variation in the strength and form of the surface markings.

When the shell is exfoliated, fine, radiating lines occur toward the front margins. The average size of the shell gives a width of about 8 mm., and in the ventral valve a nearly equal height. One specimen has a width of 11 mm.

Cardinal area well defined. It is marked by transverse striae of growth parallel to the base. The plane of the area extends backward over the cardinal line at an angle of 10° to the plane of the margin of

the shell. The delthyrium is well defined and covered by a convex deltidium, the extent of which, however, is unknown. The cardinal area of the dorsal valve is short. No details of the structure have been observed.

The cast of the interior of the ventral valve indicates short hinge teeth supported by dental plates. The markings left on the shell by the vascular system, as shown in casts, are two main vascular trunks which extend nearly in a straight line from the side of the cast of the deltidial cavity obliquely outward to the anterior fourth of the valve, where they bifurcate. The inner branch extends in toward the median line, while the lateral branches extend outward, appearing to unite with the peripheral canal. The latter arches about the space that was probably occupied by the ovarian areas, between itself and the main vascular trunks. The spaces for the attachment of the muscles between the main vascular trunks appear to have been large. No subdivision indicating the points of attachment of the different muscles have been detected. At the posterior portion of the central area there is a narrow, elevated space that posteriorly passes into the deltidial cavity. The pedicle muscles were probably attached to the front part of this elevated space. Short, radiating striæ near the margin indicate the presence of minute vascular canals.

In the interior of the dorsal valve the interior of the deltidial cavity supports a small, well-developed cardinal process or callosity. The crura are short and small, with rounded dental sockets beside them. Nothing is definitely shown of the vascular trunks or mesial impressions in the dorsal valve.

Observations.—This very pretty little species occurs in large numbers in the Gallatin limestone, Montana. In form it is not unlike the convex forms that have been referred to *B. coloradoensis* from Trempealeau, Wisconsin. It differs from the latter in having strongly marked surface plications and a narrower deltidium. From *B. striata* it differs in surface characters; also in having a more convex dorsal valve.

Formation and localities.—Upper Cambrian. Gallatin limestone, east side of Dry Creek, above Pass Creek, Gallatin Valley; west side of Dry Creek not far from mouth of Pass Creek; north of East Gallatin River near Hillsdale; on ridge between Churn and Cottonwood canyons, west side of Bridger Range, Montana.

All representatives of this species were collected by Dr. A. C. Peale, of the Hayden survey, except some obscure specimens I found at the base of the limestone above the Flathead shales 6 miles north of York, in the Big Belt Mountains, Montana.

BILLINGSSELLA PUMPELLYI, new species.

General outline subsemicircular, greatest width at the hinge line or a little in advance of it; considerable variation exists in the relative proportions of length and width; a ventral valve 8 mm. long has a width of 9 mm.; the dorsal valve is more transverse, length 5.5 mm., width 8 mm. The ventral valve is strongly convex with the umbo arching over to the apex, which is a little above the plane of the margins of the valve; a very slight median fold occurs near the front margin; dorsal valve slightly convex and with a shallow median sinus.

The surface is marked by low, sharp ribs with wide interspaces, on which fine radiating striae occur. Concentric lines and striae of growth cross the radiating striae and ribs.

The characters of the cardinal areas of the valves are almost unknown; that of the ventral valve appears to have been of moderate height and inclined but a little from the plane of the valve; one interior of the dorsal valve shows a low cardinal process. The cast of the interior of the ventral valve shows the presence of a tripartite elevated umbonal space into which the strong main vascular sinuses extend, as in *Billingsella coloradoensis*; the sinuses extend forward nearly to the front margin of the valve. Of the interior of the dorsal valve only the presence of a strong median ridge is known.

Observations.—This species is one of the costate forms of the type of *B. coloradoensis* and *B. romingeri*. It differs from them in surface characters. It may be considered the trans-Pacific representative of *B. coloradoensis*.

The specific name is given in recognition of the work of Raphael Pumpelly upon the geology of China.

Formation and locality.—Middle Cambrian. Chao Mi Tien limestone. Three miles southwest of Yen Chuang, also Chao Mi Tien, Shantung, China. Collected by Eliot Blackwelder and Bailey Willis, of the Carnegie Institution Expedition, 1903.

BILLINGSSELLA RICHTHOFENI, new species.

This species is represented by two specimens of the exterior of the ventral valve. They vary from 4 to 5 mm. in length and width, the length and width being about the same. The outer surface is marked by fine, obscure, radiating ribs and very fine concentric striae. The general form is much like that of the ventral valve of *Billingsella pumpellyi*. It differs from the latter in having a shorter hinge line in proportion to the width, the more uniform and stronger convexity of the surface, and the more elevated apex.

The species is named after Dr. Ferdinand von Richthofen.

Formation and locality. —Middle Cambrian. Chang Hsia limestone. Two and one-half miles south of Yen Chuang, Shantung, China.

Collection of Mr. Eliot Blackwelder, Carnegie Institution Expedition to China.

BILLINGSSELLA ROMINGERI Barr.

Orthis romingeri BARR, Ueber die Brachiopoden der Sil. Schi. Böhmen, II, Abth. Haidingers Naturw. Abhandl., II, 1848, pp. 203, pl. xvii, fig. 8.

Orthis romingeri BARR, Syst. Sil. Böheme., V, 1879, pl. LXII, figs. 1-4.

Orthis romingeri POMPECKJ, Die Fauna des Cambrium von Tejšovic und Skrej in Böhmen, Jahrbuch der k. k. geolog. Reichsanstalt, 1895, XLV, 1896, Pts. 2 and 3, pp. 513, pl. xv, figs. 1-5a.

Shell transverse, the general outline being irregularly subquadrate to subsemicircular. On the ventral valve the cardinal line slopes toward the beak at a low angle, while in the dorsal valve it is approximately straight. In some shells the greatest width is at the hinge line, while in others it is about the middle of the valve. There is considerable variation in length and breadth.

The ventral valve is rather strongly convex and the dorsal valve moderately so. The dorsal valve is slightly flattened from the umbo to the frontal margin, the flattening sometimes taking the form of a shallow depression. A low, broad, mesial sinus occurs on the dorsal valve that is strongly marked in the young shells. The surface is marked by rounded, bifurcating, radiating costæ, crossed by concentric lines of growth and undulating concentric striæ. The radiating costæ vary in size and character in specimens from the same locality. In some specimens they are very regular, while in others there will be wider interspaces or a variation in the manner of interpolation. The ridges of growth also vary in strength and elevation in different shells.

The largest shell in quite a large quantity of material has a height in the ventral valve of 13 mm. and in the dorsal valve of 10 mm., with a width of 15 mm. Cardinal area of ventral valve rather high and slightly incurved; it is marked by transverse striæ of growth that cross it parallel to its base; the plane of the area extends backward at an angle of about 10° to the plane of the margin of the shell; the delthyrium is rather large; a deltidium is indicated in some of the casts, but none of the specimens show it clearly. The cardinal area of the dorsal valve is about one-half the length of that of the ventral valve. It extends backward at an angle of more than 45° to the plane of the margin of the valve, and is divided midway by a strong delthyrium, which is covered, for a part of its distance at least, by a convex chidium.

The traces of the vascular system in the ventral valves are seen in the main vascular trunks which extend well forward toward the front margin, where they appear to bifurcate, the inner branch extending toward the median line, and the lateral branches apparently connect-

ing with the peripheral canal that arches backward about the ovarian areas between it and the main vascular trunks. No points of attachment of the various muscles in the ventral valve have been observed. The area in which the diductor muscles are attached is well marked in some specimens, and the cardinal process of the dorsal valve in others. There are also shown in the dorsal valve the anterior adductor impressions. In the interior of the dorsal valve the deltidial cavity separates a small cardinal process or callosity, which is straight or subtriangular. The crura are relatively long and very prominent, with distinctly defined dental sockets beside them.

Observations.—This species was well illustrated by M. Barrand. In the material of the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts, there is a fine series illustrating the interior of the ventral and dorsal valves, that through the kindness of Dr. Alexander Agassiz I was enabled to study.

The species in its external and internal shape varies so decidedly from all described forms that it is not necessary to point out differences between them.

Formation and locality.—Middle Cambrian. Argillites and fine-grained sandstone near Skrejš, Bohemia.

BILLINGSSELLA SAFFORDI, new species.

General outline of ventral valve subsemicircular and of dorsal valve transversely broad oval; greatest width of valves at about the center; hinge line straight and a little shorter than the greatest width of the shell. A typical ventral valve has a length of 9 mm., width 9 mm. Dorsal valve, length 10 mm., width 12 mm. Biconvex, the ventral valve being more elevated at the umbo than the dorsal. Surface as far as known smooth or marked by concentric striae and lines of growth.

Ventral valve with umbo curving over and terminating in the small apex that incurves a little over the area; area about one-half the elevation of the valve, a broad delthyrium is partially covered by a convex deltidium; casts of the interior indicate a low, tripartite pseudospondylium, and one cast shows strong main vascular sinuses extending from the lateral divisions of the pseudospondylium nearly to the front margin. Dorsal valve with low area and small pseudocruralium; the casts are too imperfect to show any other details.

Observations.—This species occurs in the same region as *B. harlanensis* and also has a smooth shell; it differs in being of equal length and breadth and in having less strongly marked interior characters.

The species is named after Prof. James M. Safford, former State geologist of Tennessee.

Formation and locality.—Middle Cambrian. Rome sandstone, along First Creek Gap, 4 miles north-northeast of Knoxville, Tennessee.

BILLINGSSELLA SALEMENSIS Walcott.

Orthis salemensis WALCOTT, Amer. Jour. Sci., 3d ser., XXXIV, 1887, p. 190, pl. I, figs. 17, 17a; Tenth Ann. Rept. U. S. Geol. Sur., p. 612, pl. LXXII; figs. 6, 6a.

Shell about the average size of the Cambrian species of the genus. Transversely subquadrilateral; front broadly rounded and slightly sinuate midway; hinge line as long as the greatest width of the shell.

Ventral valve convex, most elevated about one-fourth the distance from the beak to the anterior margin; beak small and incurved to the margin of the medium-sized area; the surface of the area and the foramen have not been observed; mesial sinus broad and shallow, marked by a low median rib and laterally by two costæ on each side, a third appearing just outside the sinus.

The dorsal valve, associated in the same hand specimen of limestone, is slightly more convex; frontal margin with a rather deep sinuosity to receive the projection of the ventral valve; median fold broad and but slightly elevated, marked by two or three low costæ; the beak appears in the broken specimen in the collection to be scarcely elevated above the surface of the shell, and to terminate at the cardinal margin; area unknown.

The surface of both valves is marked by fine concentric lines of growth, and low, rounded costæ, varying in number from six to seven.

In the broad costæ and the general aspect of the shell this species is unlike any known to me from the Cambrian, with the exception of *B. whitfieldi*, from which, however, it differs in strength and character of costæ and outline of valves.

Formation and localities.—Lower Cambrian; limestone interbedded in the shaly slates $1\frac{1}{2}$ miles south of Salem; 1 mile south of Shushan, and near Rock Hill school house (No. 8), Greenwich, Washington County; bedded limestone of *Olenellus* zone on north side of Beman Park, Troy, New York. It is also present in limestone boulders of the Cambrian conglomerate at Metis, on the St. Lawrence, below Quebec. *Olenellus* sp. *Hyolithellus micans*, etc., occur in association with it.

Cat. U. S. Nat. Mus., No. 17443.

BILLINGSSELLA STRIATA, new species.

The form of the ventral valve of this species is much like that of *B. plicatella*. It differs in having a finely striated outer surface, and in the strong development of the main vascular sinuses and the broader deltidial cavity. The only two specimens of the dorsal valve are nearly flat.

Formation and locality.—Middle Cambrian? The character of the matrix indicates that the specimen came from the Flathead formation. Forks of Pole Creek above Cherry Creek Valley, Madison County, Montana.

BILLINGSSELLA WHITFIELDI Walcott.

Katorgina whitfieldi WALCOTT, Mong. U. S. Geol. Sur., VIII, 1884, p. 18, pl. ix, figs. 4, 4a.

Billingsella whitfieldi SCHUCHERT, Bull. U. S. Geol. Sur. No. 87, 1897, p. 159.

Shell convex, hinge line straight and a little less than the greatest width of the shell, sides rounding regularly into the slightly convex frontal margin.

Ventral valve quite convex, elevated along the center to form a flat depressed fold, and sloping quite rapidly from this to the lateral and cardinal margins; median elevation with about five rather faintly defined, simple plications, that reach up to the higher portion of the valve; beak small, a little depressed, and rising above the area; cardinal margins straight and diverging from the beak at an obtuse angle; character of area unknown.

Dorsal valve depressed convex, with a rather wide, shallow, median depression, and two short plications on each side of it toward the front, which are obsolete in some of the specimens; the area between the cardinal edges and the elevation of the sides of the mesial depression is depressed and corresponds to the flattened lateral slope of the ventral valve.

Surface marked by fine, very clearly defined concentric striæ that are crowded together into narrow ridges and are subparallel to the front and lateral margins of the shell.

B. whitfieldi belongs with the group of species including *B. salemensis* or shells with coarse plications and very fine concentric striæ. The latter species occurs with the *Olenellus* fauna in eastern New York, and *B. whitfieldi* in the Middle Cambrian of Central Nevada.

Formation and locality.—Lower Cambrian. Prospect Mountain group, beneath the Secret Canyon shale, on the west side of Secret Canyon, Eureka District, Nevada.

OTUSIA, new subgenus of **BILLINGSSELLA**.

This name is proposed to include *Orthis sandbergi* of N. H. Winchell, which is the only species known at present. The subgeneric and species characters are included in the description of the species.

BILLINGSSELLA (OTUSIA) SANDBERGI Winchell.

Orthis sandbergi N. H. WINCHELL, Fourteenth Ann. Rep. Geol. Nat. Hist. Sur. Minnesota, 1886, p. 318, pl. II, figs. 8, 9.

Orthis ? sandbergi WALCOTT, Mong. XXXII, U. S. Geol. Sur., 1899, p. 452, pl. LXI, figs. 2, 2a-d.

Shell small, transverse, subquadrate in outline, exclusive of the acute cardinal extremities. Valves slightly convex, with a straight hinge line longer than the greatest width of the shell; cardinal area narrow but well developed on each valve and divided by a rather large open delthyrium.

The ventral valve slightly flattened at the cardinal extremities, rising toward the center with a convex triangular swelling, broadening from the narrow beak to the front; beak small, rounded, and extending slightly beyond the hinge line. Dorsal valve flattened at the cardinal extremities, with well-marked rounded ridges rising between them, and a rather broad, well-defined median sinus; beak very small, slightly encroaching upon the hinge line.

Surface marked by fine, regular, radiating striae, between which one or more faint intermediate striae are sometimes visible; under favorable conditions very fine concentric striae can be seen, and there are also usually present more or less distinctly marked lines of growth.

Very little is known of the interior of the ventral valve. Two fragments of the posterior portion show a broad delthyrium, strong teeth, and a broad umbonal cavity opposite the delthyrium. In the ventral valve the area is narrow and divided by a broad delthyrium, which has a strong cardinal process that extends forward nearly three times the length of the area. Anteriorly, it rests on a broad ridge that extends forward, gradually broadening out and disappearing at the anterior margin of the shell.

In my former description^a I stated that "the generic character of this species has not been fully ascertained, but the material from the Yellowstone National Park and specimens from the typical locality at Red Wing, Minnesota, lead me to think that this can not be referred to the genus *Billingsella*. It appears to be an *Orthis* of the *Plectorthis* group of Hall and Clarke." A more thorough study of this species and the forms referred to *Billingsella* leads me to place it in a subgenus of *Billingsella* on account of its surface character, the character of the delthyrium in the two valves, and the strong cardinal process and median ridge in the dorsal valve.

A comparison of the specimens of this species from a typical locality at Red Wing, Minnesota, with those from the Yellowstone National Park, shows the two shells to be specifically identical as far as the comparison of casts in sandstone can be made with well-preserved shells on the surface of limestone. This is the only species of this type known to me in the Cambrian fauna.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Red Wing, Minnesota. Upper Gallatin limestone, north side of Elk Pass, between Buffalo and Slough Creeks, Yellowstone National Park, Montana.

NISUSIA, new genus.

Form subquadrate to transversely semioval. Shell substance fibrous; surface with narrow, radiating ribs that support irregularly distributed spines on their crests.

^a Mong. XXXII, U. S. Geol. Sur., p. 453.

Ventral valve elevated and usually much more convex than the dorsal, and in most species a mesial sinus appears on it. Area high, vertical, or inclined backward; delthyrium large and partially closed with a convex deltidium; teeth strong and supported by dental plates that extend outward, also inward forming on the inside a shallow spondylium. Dorsal valve moderately convex with only a trace of a median elevation; usually the surface is convex, but it may be slightly concave from the umbo to the margins; crura well developed with the crural plates extended so as to form a shallow cruralium. No traces of a cardinal process have been observed in the dorsal valve.

Type of genus.—*Orthis festinata* Billings. Lower Cambrian. Only one other species is now known, *Nisusia alberta* from the Middle Cambrian horizon.

The species referred to *Nisusia* and the subgenus *Jamesella* are:

Name.	Cambrian.		
	L.	M.	U.
1. <i>alberta</i> , new species.....		x	
2. <i>festinata</i> Billings.....	x		
<i>festinata</i> var. <i>transversa</i> Walcott.....	x		
<i>Jamesella</i> , new subgenus of <i>Nisusia</i> .			
1. (<i>Jamesella</i>) <i>antii</i> , new species.....	x		
2. (J.) <i>argenta</i> , new species.....	x		
3. (J.) <i>erecta</i> , new species.....		x	
4. (J.) <i>kuthani</i> Pompeckj.....	x		
5. (J.) <i>perpasta</i> Pompeckj.....	x		
<i>perpasta</i> var. <i>macra</i> Pompeckj.....	x		
<i>perpasta</i> var. <i>subquadrata</i> Pompeckj.....	x		
6. (J.) <i>utahensis</i> , new species.....		x	
7. (J.) species undetermined.....	x		

NISUSIA ALBERTA Walcott.

Orthisina alberta WALCOTT, Proc. U. S. Nat. Museum, XI, 1888, p. 442.

Billingsella alberta SCHUCHERT, Bull. U. S. Geol. Sur. No. 87, 1897, p. 158.

Orthisina alberta MATTHEW, Trans. Roy. Soc. Canada (ser. 2), VII, 1902, Sec. 4, p. 109.

Shell transversely suboval, front broadly rounded; the straight hinge line is shorter than the full width of the valves. Surface of shell with numerous radiating ribs that increase by interpolation; on a shell 19 mm. in width there are four ribs near the front margin in a distance of 3 mm.; the ribs are rather narrow and sharp crested, the interspaces being wider than the ribs. A cast of the outer surface of a shell in silicious shales shows numerous strong spines irregularly distributed on the ribs very much as in *N. festinata*.

Ventral valve elevated at the umbo and apex in some shells, convex and rounded over toward the area in others; area varying in height in different shells, usually elevated and overhanging the hinge line, it is divided by a strong delthyrium that is covered by a convex deltidium of varying length, arched at its front margin and divided by longitudinal lines into three parts.

Dorsal valve gently convex; area low and a little inclined over the hinge line; delthyrium broad with a narrow chilidium. Casts of the interior show a broad, well defined pseudocruralium, and just in advance of it the adductor muscle scars.

Observations.—This species recalls at once *N. festinata* by its elevated ventral valve and spinose surface; it differs from it by its transversely suboval outline, large umbonal muscle cavity (pseudocruralium) in the dorsal valve, and sharp-crested ribs. *N. (Jamesella) perpasta* has the general form and surface characters of this species. A marked difference in appearance is caused by *N. alberta* occurring in a silicious shaly matrix and *N. (Jamesella) perpasta* as casts in a quartzitic sandstone and the strong surface spines of *N. alberta* are sparingly represented on the latter.

Formation and locality.—Middle Cambrian. Mount Stephen shale, 2,000 feet above Olenellus zone, Mount Stephen section. British Columbia.

The original specimens were from the collection of Dr. Karl Rominer. I now have material belonging to the Geological Survey of Canada, United States National Museum, and Mr. Byron E. Walker, of Toronto, Canada.

NISUSIA FESTINATA Billings.

Orthisina festinata BILLINGS, Geol. Sur. Canada, Pal. Foss., I, 1861, p. 10, figs. 11, 12; Geol. Vermont, II, 1862, p. 949, figs. 350-352; American Jour. Sci., 2d ser., XXXIII, 1863, p. 105; Geol. Canada, p. 284, fig. 289.

Orthisina festinata WALCOTT, Bull. U. S. Geol. Sur. No. 30, 1886, p. 120, pl. VII, figs. 7, 7a, 7b; Tenth Ann. Rept. U. S. Geol. Sur. 1891, p. 613, pl. LXXII, figs. 7, 7a, 7b.

Billingsella festinata HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 230.

General form subquadrate to transversely semioval, with the cardinal extremities subacute to obtusely angular. Hinge line straight, usually equal to or greater in length than the width of the body of the shell. Shell substance fibrous.

Surface with narrow, rounded, radiating ribs, that increase by both bifurcation and interpolation; the ribs are roughened by concentric lines and ridges of growth that arch about the base of strong, acute spines; the spines are located on the ribs, usually just back of a ridge of growth; they are in more or less irregular, concentric rows toward the front of the shell, but on the central portions they may be scattered without any system of arrangement; each spine is larger at the base, tapering rapidly, and curving gradually backward at about one-half its length.

The ventral valve is more or less elevated at the umbo and apex; in some examples it is subpyramidal, where the height is to the length as 3 to 6, and width 9 mm.; in other shells the proportion is 4 to 11, and width 17 mm.; the slopes from the apex to the margins are nearly straight or slightly convex; the form of the umbo and apex varies from

a broad rounded umbo, terminating in a minute beak curving over the area, to an erect, vertical, more or less rounded apex, with a broad base rising abruptly from the elevated umbo; a shallow, rounded, median sinus occurs on most individuals, but it is sometimes absent. Area high, and crossed by transverse lines of growth; it is usually inclined over the hinge line, but it may be vertical or inclined forward; it is divided by a strong delthyrium, which is covered by a convex deltidium that the author of the species, Doctor Billings, describes as perforate at the apex.^a

I have not been able to verify this in a large collection of material from various localities; casts of the interior of the extended beak indicate but do not prove that there was a perforation; the front edge of the deltidium is arched so as to leave a space of variable height between it and the plane of the hinge line; in three examples the area is divided into three parts by longitudinal lines, two of the lines bound the delthyrium, and one on each side corresponds in position to the "flexure" lines in *Obolus* and *Hipparionyx*. A cast of the interior of a low ventral valve shows a broad delthyrium, strong teeth, and supporting dental plates, which are produced on the inside, so as to form a short, elevated base (pseudospondylium), probably for the adductor muscles, and on the outside the plates are continued partially about the space occupied by the points of attachment of the diductor muscles.

The dorsal valve is moderately convex at the umbo, sloping gently from there to the margins; usually the slope is convex, but in one example it is slightly concave; area narrow and vertical or slightly inclined over the hinge line; casts of the interior show the crura, points of attachment of posterior adductor scars, and area of attachment of diductor scars. Vascular and ovarian markings unknown.

Observations.—This shell has a wide geographic distribution. I have collected it at the type locality in the township of Georgia, Vermont; at Bic on the lower St. Lawrence River, and near the city of York at Emigsville, in central Pennsylvania. The matrix at Bic is a finely granular, slightly arenaceous limestone, in which the outer form of the shell is well preserved, but the spines are rarely seen; at Swanton and Georgia, Vermont, the shell occurs in siliceous limestone and arenaceous shale, and a cast of the outer surface shows the spines; the material from the finely arenaceous limestone at the Emigsville localities, discovered by Mr. E. Wanner, of York, is the best preserved, and affords excellent casts of the interior and exterior of the valves. In all of the localities the variation in the form and elevation of the

^a Through the courtesy of Dr. J. F. Whiteaves, of the Geological Survey of Canada, I had the opportunity of examining the types of *Orthisina festinata*. None of them preserve the apex of the deltidium, so it is impossible to determine upon what Mr. Billings based his statement that the deltidium is perforate.

ventral valve occurs, specimens of the ventral valve from Bic show a shorter deltidium than is usually present.

A number of exfoliated shells occur in the collection from the dark gray compact limestone of eastern New York that are somewhat doubtfully referred to this species.

Nisusia festinata is a strongly marked species that appears to have but one near representative in *N. (Jamesella) perpasta*. The latter differs in the absence of spines and form of the ventral valve.

Formation and locality.—Lower Cambrian. Upper portion of Olenellus zone, Georgia formation. In limestone "lentile" about 2 miles east of Swanton; in silico-argillaceous shales, with *Olenellus thompsoni*, Parker's quarry, town of Georgia; and in arenaceous magnesian limestone about 2 miles east of Highgate Springs, Franklin County, Vermont. Also in dark gray limestone interbedded in siliceous shales 2 miles south of Middle Granville, Washington County, New York.

In limestone boulder of the conglomerate on the east side of the entrance to Bic Harbor. Province of Quebec. Fragments of *Olenellus* and *Microdiscus* occurred in association with *N. festinata* in the limestone boulders.

Emigsville limestone, on left bank of Codorus Creek, below Meyers Mill, near Emigsville, 4 miles from York, Pennsylvania.

NISUSIA FESTINATA TRANSVERSA Walcott.

Orthisia ? *transversa* WALCOTT, Bull. U. S. Geol. Sur. No. 30, 1886, p. 121, pl. VII, figs. 5, 5a.

Original description.—Shell small, transversely subquadrangular in outline, front broadly rounded, angle formed by the union of the cardinal slopes of the ventral valve 155° to 165° , hinge line straight and as long as the width of the shell. Area of the ventral valve of moderate height, bent back from the hinge line, divided by a triangular foramen that is higher than wide, and covered by a convex deltidium; the area of the dorsal valve is bent back at more than a right angle to the hinge line; foramen higher than wide, covered by a deltidium.

Surface marked by numerous radiating, fine, even costae, eight in a distance of 3 mm., on the frontal margin of the ventral valve; a few concentric lines of growth cross the radiating costae, but not so as to give them a nodose character.

Interior characters unknown. The fine radiating striae and transverse form distinguish this from other described species known to me.

Since 1886 I have obtained a much larger series of specimens, and do not think that this form should be considered more than a variety of *N. festinata*.

Formation and locality.—Lower Cambrian, Georgia formation. Silico-argillaceous shales of Parker's quarry, town of Georgia, Franklin County, Vermont.

JAMESELLA, new subgenus of **NISUSIA**.

There are several species of Lower Cambrian brachiopods that differ from *Nisusia festinata* in the absence of the strong spines on the radiating ribs. This character is so marked that I separate the species without it as a subgeneric group. The subgeneric name is in memory of Dr. Joseph F. James.

Type of subgenus, *Orthis perpasta* Pompeckj.

NISUSIA (JAMESELLA) AMII, new species.

Ventral valve convex, elevated at the umbo, with the beak slightly incurved; area high, vertical, slightly incurved; delthyrium triangular, higher than its greatest width and covered by a convex deltidium, which is imperforate. Surface of shell marked by numerous fine, rounded, equidistant ribs that increase by interpolation; about 8 ribs in a distance of 2 mm. at frontal margin. Size: Length, 8 mm.; width, 10 mm.; elevation at umbo, 4 mm.

The front margin of the deltidium broken so that it is impossible to state whether it was arched as is the deltidium of *Nisusia festinata*. There is no trace of a foramial aperture in the deltidium. The fine, regular ribs and high area serve to distinguish this from other species of the genus. Dorsal valve unknown.

The specific name is that of Dr. H. M. Ami, of the Canadian Geological Survey.

Formation and locality.—Lower Cambrian. I found this shell in a limestone boulder of the Sillery conglomerate in association with fragments of *Olenellus*, 4 miles below Quebec, on south shore of St. Lawrence River, Canada.

NISUSIA (JAMESELLA) ARGENTA, new species.

Only the ventral valve is known of this species. Its outline is subrectangular with hinge line a little shorter than the greatest width. Strongly convex with a keel-like median elevation extending from the incurved beak over the elevated umbo to the front margin, with gradually increasing width. Surface marked by fine, concentric striae of growth and about five sharp, elevated radiating ribs on each side of the two ribs on the median ridge. Area low, with the minute beak curving down to and possibly slightly over it.

This shell is represented by two specimens that have such strong characters that I unhesitatingly give them a specific name. The only form known to me that resembles them is *N. (J.) kuthani* of Bohemia.

Formation and locality.—Lower Cambrian. In shaly limestone containing fragments of *Olenellus*. Three miles southeast of Barrel Spring, one-half mile east of road, Silver Peak District, Nevada.

NISUSIA (JAMESELLA) ERECTA, new species.

General form transversely semioval; hinge line a little shorter than the greatest width; valves subequally convex. Surface marked by strong, broad, sharply rounded ribs, three at the frontal margin in a distance of 2 mm.; the ribs appear to be simple and unbifurcated from the umbo to the margin, but owing to the small size of the shell this statement may be modified by discovery of other specimens.

Ventral valve convex; elevated at the umbo, apex worn by attrition, but marginal. Area high, very slightly inclined backward; delthyrium large, triangular, length and width equal; deltidium convex, imperforate, and nearly covering the delthyrium. Dorsal valve regularly convex, most elevated at the umbo and curving over to the rather low area.

This species is distinguished by its strong, regular ribs and the regular convexity of the dorsal valve.

Formation and locality.—Middle Cambrian. Limestone at the south end of Timpapute Range, Groome District, Nevada.

NISUSIA (JAMESELLA) KUTHANI Pompeckj.

Orthis kuthani POMPECKJ, Jahrbuch k. k. Geol. Reichsanstalt, XLV, 1896, p. 514, pl. xv, figs. 8-13.

(*Orthis romingeri* KREJCI, Novak, K. Feistmantel, Kusta, Katzer, Wentzel, Jahn.)

Original description.—Outline subrectangular, hinge edge straight with angles protracted but a short distance; length to breadth as 3:4, often less.

Ventral valve highly arched. Apex drawn forward, but not curved toward the dorsal valve at all, or in rare cases but slightly. Area high, steep, with sharp areal edges and high, triangular foramen. Owing to the state of preservation, the details of the inside of the valves can not be well observed.

Dorsal valve flatter, with rather decided arching on side edge and frontal edge, with sinus always distinct, which corresponds to a faint swelling at the frontal edge of the ventral valve. The area is very low with a small triangular foramen. Crural processes narrow, considerably divergent.

The surface is ornamented with narrow sharp ribs, increasing by interpolation. The ribs are divided by interspaces which are considerably broader than the ribs. In the interspaces there is frequently seen a lower, thread-like rib. The number of ribs is 30 to 36. The ribs are mostly very distinct on the internal casts also. Sometimes internal casts are found which show remarkably few ribs, and which in this respect and also by their greater breadth approach *Orthis perpasta* var. *macra*.

The present species has thus far been called, after Kusta's example, *Orthis romingeri*, but it differs from that species (*a*) in the ventral valve, its apex never being so strongly curved as in *Orthis romingeri*, and in most cases not curved at all; (*b*) in the dorsal valve, which in the present species is more strongly arched with a more decided sinus; (*c*) in the sculpture, inasmuch as the ribs are narrower, sharper, fewer in number, and separated by wider interspaces than in *Orthis romingeri* Barr.

This species, eminently characteristic of the lower conglomerate zone of the Kamenná hůrka near Tejšovic, was found in thousands of specimens (impressions and internal casts) at the locality mentioned, in conglomerate-like, quartzitic sandstone and in the greywacke intercalations. I saw the species in similar rock from Gröss Lohovic southwest of Skrej. (Collection of the Bohemian University at Prague.)

Observations.—In the material of this species Doctor Pompeckj sent me, there is one cast of a ventral valve that shows that a convex deltidium covered about two-thirds of the delthyrium; its front margin was arched so as to leave considerable space open between it and the place of the hinge line.

There is a decided mesial sinus in most specimens of the dorsal valve, but in some it is flattened so as to scarcely break the uniform low convexity of the valve; the strength of the mesial elevation of the ventral valve also varies from a marked ridge to a flattened median space.

The species appears to be quite distinct from any described Cambrian form.

Formation and localities.—Lower Cambrian sandstone of lower conglomerate zone. Localities in Bohemia as mentioned above.

NISUSIA (JAMESELLA) PERPASTA Pompeckj.

Orthis perpasta POMPECKJ, Jahrbuch k. k. geol. Reichsanstalt, XLV, 1896, p. 515, pl. xv, figs. 15–18.

Original description.—Outline subrectangular, with straight hinge line and slightly bent frontal margin; cardinal angles slightly drawn in; the length is little more than half the breadth, the greatest breadth being in the middle of the valves. Both valves are very strongly arched.

The ventral valve has a high, steep area, with a large, triangular foramen, and the areal edges are rather sharp. The apex is not drawn forward beyond the hinge line. From the apex to the frontal edge there is a sinus which gradually increases to a considerable breadth. The dorsal valve, which is also strongly arched, has a very low and indistinct area, with a low, broadly triangular foramen. On the frontal margin a strong, broad swelling of the edge of the valve corresponds to the sinus of the ventral valve.

Judging by some internal casts and impressions, the shell is ornamented with some 40 broad ribs, of which about half are inserted between the primary ribs at various distances from the apex. Concentric lines of growth cross the ribs. On the top of the shells, along some of those lines of growth (1 or 2) the sections of the shell are found to be imbricated; near the frontal edge such imbrication is present more frequently in very short intervals.

Orthis perpasta differs from *Orthis Kuthani* by its greater breadth, by the almost uniform and much stronger arching of both valves, and also by the fact that in the former species the ventral valve bears a sinus, while in *Orthis Kuthani* the sinus is on the dorsal valve.

About 30 internal casts and impressions of dorsal and ventral valves were found in the conglomerate-like, quartzitic sandstone, and more rarely in the greywacke sandstone of the lower conglomerate zone on the “Kamenná hůrka” near Teřovic.

Observations.—Doctor Pompeckj very kindly sent me several fragments of sandstone containing casts of the interior and exterior of the valves. The specimens illustrated by Doctor Pompeckj are smoother than most of those sent to me, but the description corresponds to the ribbed specimens, and a few nearly smooth interior casts occur in association with the more strongly ribbed shells. The convexity of the ventral valve is quite variable but is usually considerable. One of the

marked characters of the dorsal valve is the large transverse space—pseudocruralium—beneath the umbo. In one example it is crossed vertically by the main vascular sinuses. What may be a trace of a low, simple, rounded cardinal process is shown in one cast. The crura were strong, with small dental sockets beside them.

V. (J.) perpasta resembles *Nisusia alberta* in form and convexity, but it does not have a spinose surface.

Formation and locality.—Lower Cambrian. Quartzitic sandstone of the "Skrej-band." Kamenná hůrka near Tejšovic; also Skrej (Slapnický) Bohemia.

NISUSIA (JAMESELLA) PERPASTA MACRA Pompeckj.

Orthis perpasta macra POMPECKJ, Jahrbuch k. k. geol. Reichsanstalt, XLV, 1896, p. 516, pl. xv, fig. 14.

Original description.—Some internal casts and impressions of dorsal valves agree in outline perfectly with the dorsal valves of *Orthis perpasta*, but differ from the type form by much less arching and ribs farther apart.

Occurs in the same localities as *Orthis perpasta*.

Observations.—The gradual increase in the width of the interspaces between the ribs, from a very narrow space to several times the width of the rib, makes this variety of doubtful value.

NISUSIA (JAMESELLA) PERPASTA SUBQUADRATA Pompeckj.

Orthis perpasta var. subquadrata POMPECKJ, Jahrbuch k. k. geol. Reichsanstalt, XLV, 1896, p. 516, pl. xv, figs. 19, 20.

Original description.—As compared with the type form, this variety is distinguished by less breadth, the length being to the breadth as 3 to 4. The anterior angles of the straight hinge edge are drawn in somewhat more than in *Orthis perpasta* f. typ. The ventral valve is higher, with higher and steep area, pierced by a large triangular foramen. The sinus, which extends from the high vertical apex to the frontal edge, is bordered by obtusely rounded edges. Dorsal valve proportionally more bulged than in the type form. Sculpture as in *Orthis perpasta* f. typ.

The outer form strikingly recalls *Orthisinae*; but the pseudodeltidium, the median septum, and the spondylium of the ventral valve are lacking.

Orthis perpasta var. subquadrata was found in several internal casts and impressions, together with *Orthis perpasta* f. typ., more rarely in greywacke sandstone than in the conglomerate-like, quartzitic sandstone.

Observations.—This variety apparently is not constant, as ventral valves occur in the material before me that have the subquadrate form with relatively less convexity than the convex forms of the species *perpasta*.

NISUSIA (JAMESELLA) UTAHENSIS, new species.

Ventral valve transverse, strongly convex; most elevated at the umbo, which is surmounted by the upward pointing apex at the edge of the area; area slightly inclined forward from the hinge line; delthyrium large and covered by a convex deltidium. Surface marked by

several strong, rounded ribs irregularly alternating with smaller ribs; fine, radiating striae occur on the ribs and interspaces.

Only two specimens of somewhat imperfect ventral valves are known of this species. The description is of the best preserved specimen. The second specimen has a greater number of more regular ribs that increase by interpolation of short ribs. One specimen has a width of 8 mm. and a length of 4.5 mm. from the apex to the front margin, which is about the distance from hinge line to front margin.

The nearest related species is *Nisusia alberta*, from which it differs in surface ribs, forward inclination of the area, and prominent convex deltidium.

Formation and locality.—Middle Cambrian. Limestone about 50 feet above top of upper greenish shales, Rock Canyon, back of Provo, Utah.

NISUSIA (JAMESELLA), species undetermined

This doubtful species is based on an interior cast of a broken ventral valve. The width of the shell is 15 mm., and length 8 mm., with apex broken off. A broad, shallow sinus arches the frontal margin, and narrows toward the umbo. Radiating ribs narrow, about 5 in a space of 2 mm.

Formation and locality.—Lower Cambrian. Pinkish-colored limestone of Olenellus zone, coast of Labrador on Straits of Belle Isle.

EOSTROPHOMENA, new subgenus of STROPHOMENA.

The description of the type species gives all that is known of the subgenus. It differs from *Strophomena* in having the cardinal process in the dorsal valve merged into a ridge formed by the extension of the crural plates along the posterior margin, so as to cover the delthyrium and unite at the median line.

Type.—*Strophomena (Eostrophomena) elegantula*, new species.

Observations.—The cardinal process is more like that of *Orthothetes* than that of *Strophomena*; it differs from both in being more simple in its construction. It is probable that there is a group of shells having the characters of *S. (E.) elegantula*, but owing to the difficulty of obtaining interiors of the valves, it is impossible to designate them. *Strophomena aurora* Billings^a is one of these; also *Leptæna decipiens*.^b

STROPHOMENA (EOSTROPHOMENA) ELEGANTULA, new species.

General form transversely subsemicircular or subelliptical, greatest width at the straight hinge line. Surface concavo-convex, and marked by fine, radiating, even striae, separated into flat bands by stronger and more prominent striae or ribs; fine concentric striae, and more or less prominent lines of growth cross the radiating striae. The ventral

^a Pal. Foss., 1, p. 218.

^b Idem., p. 74.

valve is slightly convex, with low umbo and small, incurved apex. The dorsal valve is flattened in the umbonal region and concave toward the margins; the interior shows a narrow, rounded median furrow, also rounded crural plates that unite with the cardinal process to form a continuous ridge covering the anterior portion of the delthyrium; the dental sockets appear to have been relatively large and deep; the adductor muscle scars are a little to the front.

A ventral valve 6 mm. wide has a length of 4 mm., and a dorsal valve 5.5 mm. wide is 3 mm. in length.

Observations.—The concavo-convex valves and the ridge representing the cardinal process place this little shell with the *Strophomenoid* forms, but as no described genus possesses the characters shown, a subgenus of *Strophomena* is made to receive it.

Formation and locality.—Upper Cambrian. Ceratopyge limestone associated with *Plectorthis daunus*, Oland, Borgholm, Sweden.

ORTHIS Dalman

Subgenus PLECTORTHIS Hall and Clarke.

Plectorthis HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 194.

In their subdivision of the genus *Orthis* Dalman, Messrs. Hall and Clarke restricted the genus *Orthis* to the group of which *Orthis cal-lactis* Dalman is the type, and, among American forms, *Orthis tricenaria* of the Trenton and Hudson faunas. These forms show the existence of a transverse apical plate in the delthyrium of the pedicle valve. A second group was placed under the name of *Plectorthis* and called the group of *Orthis plicatella*, and of this the authors say:

This is a persistent form, which in American faunas, so far as known, is limited to the Trenton and Hudson River formations. While it retains the strong external ribs of the typical *Orthis*, these are not invariably simple (*O. fissicosta*, Hall; *O. triplicatella*, Meek; *O. equivalvis*, Hall, not Davidson; *O. Jamesi*, Hall); the cardinal area of the pedicle-valve is comparatively low and the valves are subequally convex. In the interior the character of the muscular scars, dental lamellæ and cardinal process is essentially the same as in Group I (*Orthis*), and the minute structure of the shell appears to be in precise agreement with that of *O. calligramma*, though no evidence of tubulose costae has been observed. In *Orthis Jamesi*, which is placed in this association, there is occasionally a deviation toward the resupinate contour exemplified in the Groups IV (*Orthis subquadrata*) and V (*Orthis sinuata*).

In the Cambrian faunas I find a group of species intermediate between the typical forms of *Billingsella* and of *Orthis*, as limited by Hall and Clarke, which appear to belong to the subgenus *Plectorthis*. This Cambrian group of shells may be defined as follows, the type of the subgenus being *Orthis plicatella* Hall, and its Cambrian representative, *Orthis remnicha* Winchell:

Diagnosis.—Shells subquadrate to transversely elongate; with or without median fold and sinus; valves subequally convex. Hinge line straight, usually forming nearly the greatest diameter of the

shell. Cardinal extremities broadly angular, rarely acuminate. Surface with radiating ribs and striae which may be crossed by concentric growth lines and striae. The ribs increase as the shell grows, by interpolation.

The ventral valve has the umbo more or less elevated over the hinge line, the apex acute and usually incurved. The area is rather broad, flat or incurved and transversely striated. Teeth short and supported by dental plates that extend to the bottom of the valve, bounding a space (pseudospondylium) including the main vascular sinuses and area of attachment of the adductor muscle scars. Delthyrium open or partially closed by a convex deltidium. The adductor muscle scars are included within a narrow median area beneath the umbo on each side of the median line, and the diductors in a more or less flabelliform area outside of the main vascular sinuses. Pedicle scars unknown.

Dorsal valve with low umbo and slightly incurved apex; area well developed with a broad delthyrium. Deltidial cavity with a straight, simple cardinal process. Dental sockets small with short crura. The adductor muscle scars are small, the anterior being nearer the median ridge, which usually extends forward from the base of the cardinal process. Shell structure impunctate, and fibrous as far as known.

Type of subgenus.—*Orthis plicatella* Hall.

Observations.—The Cambrian species referred to *Plectorthis* have relatively thin shells that retain on the interior surfaces but slight traces of the muscle scars and vascular markings, except in the umbonal cavity.

The geological range of this subgenus in the Cambrian rocks is from the upper portion of the Middle Cambrian through the Upper Cambrian, and into the Ordovician, where it terminates in the Hudson River formation.

Two of the species from strata referred to the Middle Cambrian are represented by material too imperfect for specific description; they occur with *Paradoxides* in Bohemia, and it is not improbable that they will be found to belong to some other genus. *P. retroflexa* Matthew occurs in strata referred tentatively by Matthew to his Division E2 of the Cape Breton Cambrian section. He first referred the strata to the Ordovician. Of the remaining six species referred to Middle Cambrian strata *P. wichitaensis* occurs in the upper portion of the Middle Cambrian and base of the Upper Cambrian, and *P. indianola* also occurs in both Middle and Upper Cambrian.

From the above statements it will be seen that the first representatives of *Plectorthis* in the Cambrian appear in the Middle Cambrian, and that the greater number of species, 14 out of 21, are Upper Cambrian forms.

The species referred to the subgenus are as follows:

Name.	Cambrian.		
	L.	M.	U.
1. ? <i>atava</i> Matthew			x
2. <i>christiana</i> Kjerulf			x
3. <i>daunus</i> , new species			x
4. <i>desmopleura</i> Meek			x
<i>desmopleura nympha</i> , new variety			x
5. <i>diablo</i> , new species			x
6. <i>doris</i> , new species		x	
7. <i>hastingsensis</i> , new species		x	
8. <i>iddingsi</i> , new species			x
9. <i>indianola</i> , new species		x	x
10. <i>johannensis</i> Matthew			x
11. <i>kayseri</i> , new species			x
12. <i>linmarssoni</i> , new species		x	
13. <i>newtonensis</i> Weller			x
14. <i>pagoda</i> , new species			x
15. <i>papias</i> , new species		x	
16. <i>remnicha</i> Winchell			x
<i>remnicha sulcata</i> , new variety			x
<i>remnicha tezana</i> , new variety			x
<i>remnicha winfeldensis</i> , new variety			x
17. <i>retroflexa</i> Matthew		x	
18. <i>saltensis</i> Kayser			x
19. <i>tullbergi</i> , new species			x
20. <i>wichitaensis</i> , new species		x	x
<i>wichitaensis laevisculus</i> , new variety		x	x
21. <i>wimani</i> , new species			x
22. 2 species undetermined			

PLECTORTHIS? ATAVA Matthew.

Strophomena atava MATTHEW, Trans. Roy. Soc. Canada, X, 1893, p. 102, pl. VII, fig. 8a-f.

Rafinesquina ? *atava* SCHUCHERT, Bull. U. S. Geol. Sur. No. 87, 1897, p. 338.

Description by Doctor Matthew.—Narrowly semicircular. Valves slightly arched, rather wider than the hinge line, compressed at the cardinal angles; sides of the valves nearly straight behind, regularly rounded in front.

Ventral valve moderately convex, highest and somewhat angulated at the middle of its length; umbo inconspicuous and appressed to the very narrow area.

Dorsal valve somewhat concave, especially toward the umbo, which is depressed to the general level of the valve.

The interior of the ventral valve has characters intermediate between those of *Orthis* and *Strophomena*. The ridges inclosing the cardinal muscles are shorter and closer at their extremities than in *Strophomena*, and the scar of the adductor muscle is broader and shorter, but extends half way to the front of the valve. There is a low sharp ridge at the umbo, between the branches of the posterior cardinal muscle, and the ventral cavity is faintly outlined in front. Another cast of the ventral valve of a larger individual, perhaps of this species, shows the impressions of the muscles more distinctly; in this the impression of the adductor muscle is much nearer to the hinge, being about two-thirds from the front of the valve; there is a low callus in front of the imprint of the adductor muscle.

A partly decorticated example of the dorsal valve exhibits a small bifid scar at the hinge line, due to the adductor muscle. There is no median ridge, such as is found in *Orthis*, the median sinus being almost obsolete. In front of the impression of the adductor muscle is a small, low callus.

Sculpture.—This consists of sharply raised, rounded, radiating ridges, slightly crenulated by obscure, transverse lines. These ribs are of varying size, every third or fifth rib being larger than the others; these large ribs extend outward from the umbo, and the smaller ones are intercalated between them, or spring from them. On the dorsal valve there are two main ribs in the sinus of the valve and three others

extending to the lateral margins; smaller ribs are intercalated between these. On each side of the group of ribs on the middle third of the shell are four fainter, but more strongly arched groups of ridges, which throw off minor ridges at the back, directed toward the lateral margins. On the ventral valve the small ribs are almost all intercalated and do not spring from the back of the primary ribs, as in those of the dorsal valve.

Size: Length, 12 mm.; width, 14 mm.; height of area of dorsal valve, $\frac{1}{2}$ mm., of ventral valve, 1 mm. A valve supposed to be of this species is 15 mm. long and 19 mm. wide.

Horizon and locality.—In dark shales of division 3a, at Navy Island.

Observations.—With the available data this species appears to be quite as near to *Plectorthis* as to any described genus. It does not appear to belong with the typical forms of *Strophomena* or *Rafinesquina*. The surface ribs, increasing by interpolation, and possibly bifurcation, and form of the pseudospondylium in the ventral valve, strongly suggest relationship with *Plectorthis*. It will probably require better preserved material to satisfactorily determine the correct generic reference for the species.

Formation and locality.—Upper Cambrian. Division 3a of Matthew section, St. John terrane, Navy Island, St. John Harbor, New Brunswick.

PLECTORTHIS CHRISTIANIÆ Kjerulf.

Orthis christianix KJERULF, Veiviser ved. geol. Exk, i Christiania, 1865, pp. 1, 3, figs. 8a, b, c.

Orthis christianix BROGGER, Die Sil. Etagen 2 und 3, 1882, p. 48, pl. x, figs. 14a, b, c.

Orthis christianix GAGEL, Physik. Oekon, Gesellschaft-Königsberg. Brach. Camb. und Sil. Diluvium Ost und Westpreussen, 1890, p. 34, pl. II, figs. 22a, 22b.

Orthis christianix POMPECKJ, Neues Jahrbuch, Min. Geol. und Pal., I, 1902, Tremadoc der Mont. Noire, p. 7.

This shell appears to differ from any described species by the peculiarity of the bifurcation of the radiating ribs. In all the species I have referred to *Plectorthis* the increase in the number of ribs is by interpolation and not by true bifurcation. In *O. christianix* the increase is by both methods. The reference to *Plectorthis* is somewhat doubtful, as there is not sufficient data to base a reference on the characters of the interior, cardinal areas, or convexity of the valves.

I have received a large number of specimens from Norway and Sweden labeled *Orthis christianix*. After a study of all available material only the shells from the argillaceous shale of Russelökken, Norway, and Oland, Borgholm, Sweden, appear to belong to the species. The shells in the Ceratopyge limestone (*O. dawsoni*) have ribs that increase in number by interpolation of ribs in the interspaces between the older ribs, and a second species (*P. wimani*) that occurs in both the shale and limestone has simple ribs with few interpolated beyond the umbo. Another transverse form has simple strong ribs that increase in number by interpolation of a few new ribs.

Doctor Brogger's illustration of this species suggests *O. daunus* more than the typical form of *O. christianiae*, as I understand and interpret it. "*Orthis parva*" Dalman, has sometimes been referred to *O. christianiae*.

Dr. Curt Gagel described the form usually found in the limestone, stating that the surface is covered with strong dichotomous ribs. He found it in drift blocks of the Ceratopyge limestone near Belschwitz, also in glauconitic limestone near Preussinch, Holland, and Weblau."

Dr. Ferdinand Roemer calls attention in his description of the drift in the North German plain to the fact that Remelé was the first to identify with certainty blocks of the Ceratopyge limestone of Sweden in the drift, the presence of a form like *Orthis christianiae* being part of the evidence.^b This shell was probably *Plectorthis daunus*. Doctor Roemer states in his description of the Ceratopyge limestone that a small *Orthis* (? *Orthis christianiae*) predominates.

Formation and locality.—Upper Cambrian. Ceratopyge shale, Russelökken, Christiania, Norway. Borgholm, Oland, Sweden.

PLECTORTHIS DAUNUS, new species.

This species differs from *O. christianiae* by having simple ribs that increase in number toward the front and lateral margins of the shell by interpolation of new ribs; no true bifurcation of the ribs was observed. A strong median sinus occurs on specimens of the dorsal valve in both shale and limestone. The shell is fibrous and impunctate. No traces have been seen of the fine, rounded, radiating striae that occur on the broader ribs and interspaces of *P. christianiae*. This species differs from *P. wimani* by its more transverse form and less simple ribbing of the shell.

Formation and locality.—Upper Cambrian. Ceratopyge limestone, Tören, Christiania; Slemenestad west of Christiania, Norway. Oland, Borgholm, Sweden.

PLECTORTHIS DESMOPLEURA Meek.

Orthis coloradoensis MEEK (not Shumard), Proc. Amer. Phil. Soc., II, 1870, p. 425.

Orthis desmopleura MEEK, U. S. Geol. Sur. Wyoming, Hayden, 1872, p. 295.

This shell has the general form and external characters of *O. wichitaensis*. It differs in being less convex and in the details of the radiating ribs. *O. desmopleura* differs from *O. remnicha* in its uniformly smaller size, less convexity, and in the details of the radiating ribs. The ribs have a wide range of variation, but when from the same character of matrix they are all of the same type, and the shells grade from one to the other.

^a Brach. Camb. und Sil. Geschiebe in Diluvium Prov. Ost und Westpreussen, p. 34.

^b *Lethea Erratica* in Pal. Abbordl., II, Pt. 5, 1885, p. 36.

Nothing is known of the interior of the valves beyond an imperfect cast of the area of a dorsal valve. *Orthis hamburgensis* Walcott^a is a closely related species and it may be identical.

Formation and locality.—Upper Cambrian to Lower Ordovician. The Upper Cambrian locality is on Wolf Creek, 15 miles west-southwest of Sheridan, Wyoming, on the eastern slope of the Big Horn Mountains.

The type specimens are from near the base of the Ordovician rocks at Glen Eyre, canyon of Camp Creek, near Colorado City. The species has also been found on west side of Front Creek, below Beyer Park, Colorado.

PLECTORTHIS DESMOPLEURA NYMPHA, new variety.

This variety is based on strongly convex ventral valves in which the surface is marked by fine, radiating striæ, separated into bands of 3 to 6 striæ by stronger and more elevated striæ; concentric lines and often ridges of growth occur that on some shells give an imbricated appearance to the shell beyond the umbo.

Formation and locality.—In passage beds between the Upper Cambrian and Ordovician, on north side of Tepee Creek, Big Horn Mountains, Wyoming.

PLECTORTHIS DIABLO, new species.

This species is founded on a small, transverse shell that is marked by a few prominent radiating costæ that extend from the umbo to the margin of the shell. In the cast the costæ have a sharp summit and slope evenly to a narrow space between them.

A ventral valve 9 mm. in height has a width of 14 mm., which is about the average proportion of the specimens in the collection. The casts of the ventral valve show a rather low area divided by a delthyrium, the inner angles of which have a rather strong tooth on each side. The dental plates extend backward farther than in most species of the genus, becoming attached to the bottom of the valve only near the teeth, and not extending forward as in *P. remnicha* to form a pseudospondylium. None of the specimens in the half dozen shells in the collection show the muscular or vascular markings. There may or may not be a mesial depression on either valve.

Formation and locality.—Upper Cambrian. St. Croix sandstone of Trempealeau, Wisconsin.

PLECTORTHIS DORIS, new species.

Of this species a ventral and dorsal valve occur in the collection. The general form is rounded subquadrangular. The ventral valve is strongly convex with the greatest height at the umbo, from which the

^a Mong. VIII, U. S. Geol. Surv., 1884, p. 73, pl II, figs. 5, 5a.

beak arches over a high, backward inclining area. The dorsal valve is much like the ventral in form, except that it is less convex and less elevated at the area. Surface of both valves with numerous radiating ribs that have an angular summit and an angular depression between them. The ribs increase in number toward the front by interpolation. The ventral valve has a length of 7 mm.; width 8 mm. The dorsal valve is a little shorter than the ventral.

This shell is not unlike *Plectorthis indianola* in form and surface characters. It differs in being more convex and in the absence of a sinus or median fold on either valve.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Two and three-quarters miles southwest of Yen Chuang, Shantung, China.

Collection of Mr. Eliot Blackwelder, Carnegie Institution Expedition to China.

PLECTORTHIS HASTINGSSENSIS, new species.

Shell transversely subelliptical. Surface with numerous strong, rounded, radiating ribs increasing in number by interpolation. The ribs appear to be broader and with narrower interspaces on the ventral valve; concentric ridges and fine striae of growth are a marked feature of the surface. A ventral valve 4 mm. in length has a width of 6 mm.; a dorsal valve 6 mm. long is 10 mm. in width.

Ventral valve strongly convex, most elevated on the umbo, and without mesial fold; apex incurved slightly over the delthyrium area well defined, and divided midway by a large delthyrium, it is inclined but little from the vertical.

Dorsal valve slightly convex in young shells, and becoming more so as they increase in size; area low and inclined backward over the hinge line.

Observations.—This species is unlike other described forms in the character of its ribs, with the exception of *Plectorthis johannensis*, which it resembles very closely. Doctor Matthew describes the latter species as having a very thin shell, and it is found in the Upper Cambrian at St. John. No interior features have been seen. Dr. G. F. Matthew mentions having found fragments of *Protorthis* or *Orthis* in the phosphate nodules at Hastings Cove, too imperfect for description.^a

Formation and locality.—Middle Cambrian. Upper Paradoxides zone. Hastings Cove, Kennebecasis River, at base of Paradoxides zone, Hanford Brook, in limestone and superjacent shale, St. John County, New Brunswick.

^a Trans. Roy. Soc. Canada, 2d ser., III, 1897, p. 180.

PLECTORTHIS IDDINGSI, new species.

General form and convexity much like that of some varieties of *P. indianola*. Its surface characters also approach those of the more regularly ribbed shells of the latter species. The principal difference is in the less convexity, lower umbo, and lower area of *P. iddingsi*. The interior of the ventral valve shows a short, well-defined umbonal cavity, with a strong vascular sinus on each side of it that extends well forward into the valve.

The species is named after Prof. Joseph P. Iddings of the University of Chicago, formerly of the U. S. Geological Survey, who collected the specimen.

Formation and locality.—Upper Cambrian. Gallatin terrane, south side of Gallatin Valley, Yellowstone National Park, Wyoming.

PLECTORTHIS INDIANOLA, new species.

Shell small, transverse, with the cardinal extremities rounded, angular, and in some specimens almost alate. Valves moderately convex, the ventral nearly twice as much so as the dorsal; the hinge line varies in length from slightly less than the greatest width of the shell to where, in the shells with extended cardinal extremities, it is one-fifth greater than the width of the shell across the center.

The ventral valve may or may not have a mesial depression. In some examples the depression is broad and rounded, and in others it is shallow with stronger ribs at each margin; umbo somewhat elevated, and curving over toward the hinge line, beyond which it projects, terminating in a small, incurved beak; dorsal valve considerably less convex than the ventral; beak small and projecting slightly over the hinge line. The median sinus in the dorsal valve varies from a broad, shallow depression to a narrow, rather deep furrow that gives a bilobed appearance to the valve.

The surface is quite variable in the strength and arrangement of the strong and minor radiating elevated ribs and striae. On some shells they are very fine and of nearly equal size, separated by grooves of about the same width as the ribs or striae. In other examples every third or more widely separated rib is stronger and elevated above a more or less broad interspace marked by fine ribs or costae.

Almost nothing is known of the interior of the valves. A few specimens show a well-marked umbonal cavity beneath the umbo that is much like that of *O. rennicha*. The area of the ventral valve is inclined backward at an angle of about 65° to the plane of the margin of the valve. It is rather low and broken midway by a strong delthyrium. The area of the dorsal valve is low and inclined well out over the hinge line.

Observations.—*Plectorthis indianola* is almost as variable in its form and surface markings as *P. wichitaensis*, with which it is associated at a number of localities. It differs from the latter in the bilobed dor-

sal valve, more strongly incurved umbo and apex of the ventral valve, and the general appearance of convexity and rotundity of the ventral valve. When the specimens of the two species are imperfect, or the young shells of *P. wichitaensis* occur in association with the shells of *P. indianola* it is difficult to determine positively to which species they belong.

Formation and locality.—Upper Cambrian. Top of Reagan formation, west side of Honey Creek, near SE. corner sec. 35, T. 1 S., R. 1 E., Ardmore quadrangle, northwest extremity of Arbuckle Mountains, about 4 miles east of Homer. Indian Territory, Reagan greensand, two-thirds of a mile east of Canyon Creek, 15 miles northwest of Fort Sill, SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 2, T. 4 N., R. 13 W., Wichita Mountains, Oklahoma Territory.

Middle Cambrian. Reagan Formation, SW. $\frac{1}{4}$ sec. 17, T. 4 N., R. 12 W., Wichita Mountains, 11 miles northwest of Fort Sill, Oklahoma Territory. Potosi limestone, near Potosi, Missouri. Limestone on Cold Creek, north end of gorge, opposite north end of Sponge Mountain, Llano County, Texas.

PLECTORTHIS JOHANNENSIS Matthew.

Orthisina (?) *johannensis* MATTHEW, 1891, Trans. Roy. Soc. Can., IX, 1891, p. 49, pl. XXII, figs. 13a-c.

Original description.—Shell subquadrate, doubly convex, rather flat, very thin.

Dorsal valve depressed at the sides and front, and having a broad, shallow median sinus. The valve is about one-quarter wider than long, and the hinge line is nearly as long as the length of the shell. Umbo slightly elevated, hinge plate weak and thin.

Ventral valve depressed at the sides, and having a few median ridges running from the umbo to the front of the shell. This valve is somewhat geniculated at two-fifths of its length from the umbo, and from the bend faintly raised ridges diverge to the anterior angles of the shell; behind the geniculation the surface of the shell is marked by faint undulations similar to those of *Strophomena rhomboidalis*.

The umbo is not prominent, but the back of the valve is regularly curved and the area rather low.

Sculpture.—Closely set striae radiating from the umbo and faint concentric striae mark the shell.

Size.—Length of the ventral valve, 9 mm.; width, 10 mm. Length of dorsal, 8 mm.; width, 10 mm.

Horizon and locality.—[Upper Cambrian C. D. W.] Limestone lentilles in the black shales of division 3a, Germaine street, St. John.

This species has a low umbo for an *Orthisina*, and in its form recalls the genus *Strophomena*, as also do the concentric undulations that are found on the back of the ventral valve. The dorsal valve, however, is convex, and the area of this and the ventral valve too high for a *Strophomena*. It does not appear to agree with any described species of *Orthisina*. It resembles *O. orientalis* White, somewhat in form, but is not so long nor so wide at the hinge. From *O. pepina* Hall, it differs in its lower umbo and area, shorter hinge, and smoother surface. It approaches more closely to the form from the Potsdam sandstone of the West, figured by Professor Hall, but not named, except as a *Strophomena* or *Strophodonta*.^a

^a Preliminary Notice of the Fauna of the Potsdam Sandstone. Sixteenth Rep. N. Y. State Cab. Nat. Hist., pl. VI, fig. 22.

Doctor Matthew very kindly sent me the types of this species. There is little that can be added to his very complete description. As far as known, the characters of the shell are those of the group of species referred to, *Plectorthis*.

PLECTORTHIS KAYSERI, new species.

This is a larger shell than *Plectorthis linnarssoni*, with which it is associated. Its surface is marked by numerous fine radiating striae, 4 to 5 in a distance of 1 mm., and the inner layers of the shell appear to be minutely punctate. The ventral valve is more convex than the dorsal, the latter being nearly flat in young shells. Nothing is known of the interior except one cast of the pseudospondylium of the dorsal valve, which is larger in proportion than that of *P. linnarssoni*.

The largest ventral valve has a length of 14 mm.; width, 20 mm.

This species belongs in the group of *Plectorthis* represented by *P. desmopleura* and *P. linnarssoni*.

The species is named after Dr. Emanuel Kayser.

Formation and locality.—Upper Cambrian. Lower part of Chao Mi Tien (?) limestone, 2.7 miles southwest of Yen Chuang, and Chao Mi Tien, Province of Shantung, China. Collected by Eliot Blackwelder and Bailey Willis of the Carnegie Institution Expedition, 1903.

PLECTORTHIS LINNARSSONI Kayser.

Orthis linnarssoni KAYSER, Cambrische Brach., von Liau-Tung, China, Richthofen, IV, 1883, p. 34, pl. III, fig. 1.

Original description.—Shell semielliptic in outline, broader than long, with hinge edge straight, corresponding to the greatest breadth of the shell. Large [ventral] valve moderately convex. Small [dorsal] valve slightly arched, with a sinus developing already at the umbo, and growing quite broad and deep toward the edge. Umbo of ventral valve small, area very low. Surface of shell covered with rather sharp ribs, very variable in strength, separated by narrow furrows. By reason of repeated splitting, beginning close to the umbo, the ribs appear rather as bundles of ribs. On the matrix these bundles appear as broad, obtuse-angled folds, which, owing to repeated marginal splitting in even a higher degree than on the shell itself, appear as bundles of ribs of very unlike strength. When the surface is well preserved, a delicate concentric growth striation is perceptible.

Doctor Kayser compares this shell with *Orthis hicksi* Salter, and *O. exporecta* Linnarsson, on account of the surface characters. It does not appear to be very closely related to either species, but it is in many respects allied to *Plectorthis desmopleura* and *P. wichitaensis*. *P. linnarssoni* differs from both in being more transverse.

Formation and locality.—Middle Cambrian. Lower part of Chao Mi Tien (?) limestone, 2.7 miles southwest of Yen Chuang, Province of Shantung, China. Collected by Eliot Blackwelder and Bailey Willis, of the Carnegie Institution Expedition, 1903.

PLECTORTHIS NEWTONENSIS Weller.

Orthis newtonensis WELLER, Geol. Sur. New Jersey, Pal., III, 1903, Pal. Faunas, p. 113, pl. I, figs. 3-5.

This little shell occurs in the form of casts in a sandstone that is too coarse to preserve the details of the outer surface. The cast of the interior shows fine, simple, radiating ribs that increase by interpolation and that are coarser on the ventral than on the dorsal valve. Ventral valve slightly flattened at the front; dorsal valve with a broad mesial sinus. The shell appears to have been thin. The cast of the pseudospondylium of the ventral valve shows it to have been clearly defined; the area is low and not sharply defined from the curve of the cardinal margin; it is nearly vertical to the plane of the margin of the valve. The cast of the area beneath the umbo in the dorsal valve is more triangular and less transverse than usually occurs; unfortunately the material is too imperfect to determine any details.

This species is the eastern representative in the Upper Cambrian of *Plectorthis indianola* and *iddingsi*. As far as can be determined by the material available for comparison, it is closely related to them, but it is not probable that they are specifically identical.

Formation and locality.—Upper Cambrian sandstone, Hardyston quartzite of Weller, Newton, New Jersey.

PLECTORTHIS PAGODA, new species.

Shell transverse, subsemicircular; a ventral valve 11 mm. in length has a width of 15 mm., and a dorsal valve 8 mm. in length has a width of 13 mm.; hinge line a little shorter than the greatest width of the shell; cardinal angles vary from 75° to 111° ; valves moderately convex. Cardinal area narrow in both valves and inclined backward from the hinge line. Surface marked by equidistant, narrow, low ribs, 3 in a space of 2 mm. near the front margin of a shell 10 mm. long, with fine, radiating striae between them; the radiating ribs and striae are crossed by fine, concentric striae, and lines of growth.

Ventral valve with a strong, somewhat angular, median fold, rising from a well defined depression on each side of it, or it might be designated as a very strong rib rising above the general surface of the valve from a broad, median depression; the lateral slopes are gently convex. Dorsal valve with a strong, angular, median depression, beginning at the posterior margin and gradually widening to the front; the sides of the depression rise above the general surface of the valve, and form with the outer slope a well defined, low ridge on each side that extends a little forward on the front margin to fit into the depressions on each side of the median fold of the ventral valve.

The interior of a small dorsal valve has a broad, strong median ridge corresponding to the depression on the exterior surface; a main vascular

sinus starts on each side of the base of the median ridge and arches outward and then forward about a depressed oval space on each side of the ridge; lateral branches extend from the main sinus toward the sides; the impressions of the anterior and posterior adductor muscle scars occur on the slopes of the median ridge and the oval depressions; somewhat obscure radiating lines mark the anterior portion of the surface.

Observations. This shell is distinguished by its strongly marked median ridge on the ventral valve and sinus on the dorsal valve. In general form and surface markings it is not unlike *Plectorthis desmopleura* and *Plectorthis wichitaensis*.

Formation and locality.—Upper Cambrian. Chao Mi Tien limestone, two-thirds miles west and Pagoda Hill, one mile west-southwest of Tai An Fu, Shantung, China.

Collection of Eliot Blackwelder, Carnegie Institution Expedition to China.

PLECTORTHIS PAPIAS, new species.

This species is founded to receive a form represented by two small dorsal valves from the Paradoxides zone of Newfoundland. They are moderately convex, with a low area divided by a broad delthyrium; surface marked by numerous, rounded, depressed ribs, crossed by concentric striae and ridges of growth. Length of shell 4 mm.; width, 5 mm.

Formation and locality.—Middle Cambrian. Paradoxides zone. Shales with *Paradoxides davisii* and 40 feet lower in the section. Manuels river, Conception Bay, Newfoundland.

PLECTORTHIS REMNICA Winchell.

Orthis remnica N. H. WINCHELL, Fourteenth Ann. Rep. Geol. Nat. Hist. Survey Minnesota, 1886, p. 317, pl. II, fig. 7.

Orthis? remnica WALCOTT, Mong. XXXII, U. S. Geol. Survey, 1899, pp. 451, 452, pl. LXI, figs. 3, 3a; pl. LXII, figs. 1, 1a-d.

Shell of medium size, usually slightly transverse, with an oblong, oval outline for the ventral valve, and a subquadrate to semicircular outline for the dorsal valve. Valves moderately convex, with an almost straight hinge line that varies in length from nearly the greatest width of the shell to two-thirds the greatest width; cardinal angles varying from 90° or less in the extreme forms, with extremities somewhat angular, to the other extreme, where they are very obtuse and have the appearance of being almost rounded, their angle being not less than 120°. Cardinal area narrow, but well developed on each valve, and divided by a rather large delthyrium.

The ventral valve has in some specimens a shallow mesial depression, and in some examples it is flattened toward the cardinal angles; beak small and curving down toward the hinge line, beyond which it

projects slightly. Dorsal valve slightly less convex than the ventral; beak small, scarcely projecting beyond the hinge line.

Surface marked by bifurcating, radiating costæ, that vary on shells of similar size from 16 in the space of 5 mm. to 3 in the same space. This variation is shown in the specimens from Texas, Wisconsin, and Wyoming. In well preserved specimens very fine, radiating, raised striae occur both on the costæ and on the intervening depressions. These are shown on the casts of the shells from the St. Croix sandstone of Winfield, Wisconsin, and on the larger shells from the limestones of Indian Territory and the Yellowstone National Park.

The interior of the ventral valve shows a slightly raised, rather small tripartite umbonal cavity beneath the umbo, which is the only trace of interior markings of this valve observed. The interior of the dorsal valve has a slightly elevated area upon which occurs a narrow, short median septum. The crural plates are also well shown. In casts of the interior from the St. Croix sandstone of Wisconsin the dental lamellæ of the ventral valve are finely shown, and in the dorsal valve the median septum and crural plates.

This is one of the most variable shells that occur in the Cambrian fauna. Its range of variation is such in all of the widely separated localities in which it occurs that one would scarcely hesitate, if in possession only of the extremes, to identify two well-marked species. The variation is not only in the radiating costæ, but also in the general form of the shell. This variation is expressed in three varieties that receive names, and others might be designated if more minute variations were given consideration.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Red Wing, Minnesota. Four miles north of Reedsburg and at Winfield, Wisconsin.

Near base of Upper Cambrian, on ridge eight miles east of Yellowstone River, three miles north-northeast of Mount Delano, Park County; Gallatin terrane, Crowfoot section, Gallatin Range, Yellowstone National Park. It also occurs at a slightly lower horizon on the south side of the Gallatin Valley, and specimens were collected farther to the north by Dr. A. C. Peale, opposite the mouth of Pass Creek, in the Gallatin Valley, Montana.

Upper division of Reagan formation, NW. $\frac{1}{4}$ sec. 1, T. 2 S., R. 1 E. West side of Honey Creek, near SE. corner sec. 35, T. 1 S., R. 1 E. Ardmore quadrangle; northwest extremity of Arbuckle Mountains, about 4 miles east of Homer, Indian Territory.

PLECTORTHIS REMNICA SULCATA, new variety.

This variety is founded on the strongly sulcate dorsal valve. The ventral valve shows only a slight flattening of the median portion.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Winfield, Taylors Falls, and four miles north of Reedsburg, Wisconsin.

PLECTORTHIS REMNICA TEXANA, new variety.

The rounded, subquadrate form, and the arrangement of the radiating costæ serves to differentiate this variety. This costæ vary considerably on different shells, but the tendency of the larger number is toward a surface characterized by narrow, evenly spaced, radiating ribs; fine radiating striae occur on the ribs and interspaces. A shell that is doubtfully referred to this variety occurs in the silicious Middle Cambrian limestones, 50 feet above the conglomerate series, St. Francis County; also in section 22, township 35 of Iron County, Missouri.

Formation and locality.—Upper Cambrian. Cold Creek Canyon, Burnett County; on Cold Creek, north end of Sponge Mountain, 2 miles south of San Saba County line in Llano county, Texas. Arbuckle limestone, NE. $\frac{1}{4}$ sec. 2, T. 2. S., R. 1 E., Ardmore quadrangle, Indian Territory.

PLECTORTHIS REMNICA WINFIELDENSIS, new variety.

This variety is characterized by having finer and more uniform costæ than any of the shells referred to *P. remnica*. The costæ increase by interpolation rather than bifurcation in the true sense of the word. The shorter costæ begin as very narrow, sharp ridges, merging into the sides of the larger costæ below the summit of the latter, or they may arise entirely on the interspaces between the costæ. The pseudospondylium is less strongly developed than in *P. remnica*. The young shells are usually narrower at the hinge line than the adult; but this feature is sometimes present in large shells.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Winfield. Pilot Knob, and doubtfully Trempealeau, Wisconsin.

PLECTORTHIS RETROFLEXA Matthew.

Gonambonites plana var. *retroflexa* DE VERNEUIL, Beitrage zur Geognosie des Russischen Reiches, 1830, p. 77, pl. XXV, figs. 1, 2.

Clitambonites (*Gonambonites*) *plana* var. *retroflexa* MATTHEW, Trans. Roy. Soc. Canada, 2d ser., 1, 1896, p. 266, pl. II, figs. 1a-c.

Clitambonites planus retroflexus SCHUCHERT, Bull. U. S. Geol. Survey No. 87, 1897, p. 184.

Billingsella retroflexa MATTHEW, Geol. Sur. Canada, Rep. Cambrian Rocks, Cape Breton, 1903, p. 148, pl. x, figs. 2a-e.

This species is distinguished by the fine radiating costæ on the ventral valve and coarser costæ on the dorsal. The fine, longitudinal striae are similar to those of *P. remnica*. In a specimen of the ventral valve, the pseudospondylium, area, and base of the main vascular sinuses are shown. Specimens of the dorsal valve show the cast of the strong cardinal process, dental sockets, and crura, and the ovarian areas and visceral area between. Doctor Matthew describes other features of the interior of the valves.

The character of the costæ and general features of this shell, as far as known, appear to class it with *P. remnicha* and allied forms.

Formation and locality.—Middle Cambrian. Sandstone and sandy shales, McFees Point, near George River station, Cape Breton, Nova Scotia.

PLECTORTHIS SALTENSIS Kayser.

Orthis saltensis KAYSER, Paleontographica, Primord. und Sil. Foss. Argentinischen. Rep., 1876, p. 8, pl. 1, fig. 16.

Doctor Kayser's description of the figures lead me to refer this species to the genus *Plectorthis*. The general form of the valves, the casts of the interior of the ventral valve, with the strong umbonal cavity and the radiating ribs, increasing in number by intercalation of new ribs, appear to sustain the reference.

Formation and locality.—Upper Cambrian. Sandstone of Salta and Nevado de Castillo, and at Tilcuya, Argentine Republic.

Doctor Kayser also described and illustrated the dorsal valve of a shell that he referred to *Orthis* sp. It suggests *Orthis* (*Orusia*) *lenticularis*.

PLECTORTHIS TULLBERGI, new species.

This shell occurs in the passage beds to the Ordovician at the top of the Ceratopyge zone. Its transverse outline and simple, strong ribs serve to distinguish it from *P. christianæ* and *P. daunus*.

The specific name is given in memory of Sven Axel Tullberg.

Formation and locality.—Upper Cambrian. Ceratopyge zone, Olands, Borgholm, Sweden.

PLECTORTHIS WICHITAENSIS, new species.

In general form and outline this shell is related to *P. desmopleura* and *P. remnicha*. It is more convex and differences in the radial ribbing and striation separate it from the former species, and it occurs in an older geological formation. Its convexity and surface characters distinguish it from *P. remnicha*.

A considerable number of relatively smooth shells occurs in the collections that may be designated as a variety, but it is often difficult to separate them from the more finely ribbed specimens that are typical of the species.

Formation and locality.—Upper part of Middle Cambrian and base of Upper Cambrian.

Middle Cambrian, Reagan formation. A little south of W. $\frac{1}{2}$ of sec. 2, T. 4 N., R. 13 W. One-quarter mile south of Canyon Creek Camp, 15 miles northwest of Fort Sill, Wichita Mountains. Also in same area near middle of west half of sec. 13, T. 4 N., R. 13 W.; 2 miles south and 1 mile east of Canyon Creek Camp; also in SW. $\frac{1}{4}$ sec. 17, 4 miles east of Canyon Creek Camp, 11 miles northwest of Fort Sill,

Oklahoma Territory. Cold Creek, north end of gorge opposite north end of Sponge Mountain, Llano County, Texas, Conglomerate series and 50 feet above, St. Francis County, Missouri. Upper Cambrian. Lower part of Arbuckle limestone. At small hill 2 miles southwest of Signal Mountain, Wichita Mountains, Oklahoma Territory. Reagan formation, top beds, west side of Honey Creek near SE. corner sec. 35, T. 1 S., R. 1 E.; NW. $\frac{1}{4}$ sec. 1, T. 2 S., R. 1 E., Ardmore quadrangle. Northwest extremity of Arbuckle Mountain, about 4 miles east of Homer, Indian Territory.

PLECTORTHIS WICHITAENSIS LAEVIUSCULUS, new variety.

A variety with small, narrow, numerous ribs is given the above name. Many graduations exist between it and the typical forms of *P. wichitaensis*.

Formation and locality.—Same as *P. wichitaensis* in Oklahoma and Indian Territories.

PLECTORTHIS WIMANI, new species.

This shell is distinguished from *P. christianiae* and *P. dannus* by the rounded, narrow, simple ribs, less transverse and more rounded outline. A ventral valve shows a well-defined pseudospondylium with the tripartite division as seen in *Plectorthis rennicha*. Two strong main vascular sinuses extend forward from the lateral divisions of the umbonal cavity nearly to the front of the valve, corresponding in position to those of the dorsal valve. The cast of the dorsal valve indicates the presence of rather strong crura, crural plates, teeth sockets, and delthyrium.

The ventral valve is rather strongly convex and dorsal valve about one-half as much so. The average size is 6 mm. to 7 mm. in diameter, the ventral valve being about 1.5 mm. larger than the dorsal. The largest ventral valve in the material available for study has a length of 9 mm.

The species is named after Dr. Carl Wiman in recognition of his excellent work on the cambrian faunas of Sweden.

Formation and locality.—Upper Cambrian. Ceratopyge zone. Limestone at Oland, Borgholm, Sweden. Limestone at Slemenstad west of Christiania; black argillaceous shale, Christiania, Norway.

PLECTORTHIS 2 Sp.?

Dr. J. F. Pompeckj^a mentions two species of *Orthis* from the Middle Cambrian green Paradoxides shales of Bohemia which appear, from the illustration, to belong to the genus *Plectorthis*. The mater-

^aJahrbuch k. k. geol. Reichsanstalt, XLV, p. 514, pl. xv, fig. 6 and fig. 7.

ial is too imperfect to base specific determinations upon. Doctor Pompeckj describes them as follows:

(Plate xv, fig. 6.)

Orthis sp.—In the green Paradoxides slate of the Dlouhá hora above the brook of Zbirov near Skrej there were found some impressions of dorsal valves, which depart from *Orthis romingeri*. The ribs are remarkably broad, flat, and separated by narrow interspaces; ribs may be observed to be split several times.

(Plate xv, fig. 7.)

Orthis sp.—The impression of a dorsal valve from green Paradoxides slate in the gorge above Luh near Skrej also departs from *Orthis romingeri* by its greater breadth and less distinct ribbing.

ORUSIA, new subgenus of ORTHIS.

Orthis lenticularis of authors is not an *Orthis* as restricted by Hall and Clarke.^a It appears to belong more nearly to the group of species assembled under *Plectorthis*. It departs from *Plectorthis* in its very thin shell, subequally convex valves, small umbonal cavity, and wide variation in form and surface characters, and is here placed under a new subgenus.

The only species of the subgenus *Orusia* is *O. (O.) lenticularis* which occurs in the Upper Cambrian. Another species that is doubtfully referred to the subgenus is *O. (O.?) eurekaensis* a Middle Cambrian form that appears to be nearer *O. (O.) lenticularis* than to other known species of the genus *Orthis*.

The species referred to *Orusia* are:

Name.	M. C.	U. C.
1. (<i>Orusia</i>) <i>lenticularis</i> Wahlenberg.....		x
(<i>Orusia</i>) <i>lenticularis atrypoides</i> Matthew.....		x
(<i>Orusia</i>) <i>lenticularis lyncioides</i> Matthew.....		x
2. (<i>Orusia?</i>) <i>eurekaensis</i> Walcott.....	x	

ORTHIS (ORUSIA) LENTICULARIS Wahlenberg.

Anomites lenticularis WAHLENBERG, Nova Acta Upsala, VIII, 1821, Petr. tell. Suec., p. 66.

Atrypa? lenticularis DALMAN, Kongl. Utenskaps Acad. Hand., 1827, p. 132.

Spirifera lenticularis VON BUCH, Abhandl. d. Berl. Akad., 1834, p. 48, pl. I, figs. 13, 14.

Atrypa? lenticularis HISINGER, Lethæa Svecica, 1837, p. 76.

Atrypa lenticularis KJERULF, Geol. d. südl. Norw., 1857, p. 284; Veiviser ved. geol. exc. i. Christiania omegn., 1865, p. 3, fig. 7; Syd. Norges geol. atlas, 1879, pl. XIII.

Orthis lenticularis SALTER, Mem. Geol. Sur. Great Britain, III, 1866, p. 339, pl. IV, figs. 8-10.

Orthis lenticularis DAVIDSON, Geol. Mag., V, 1868, pl. XVI, figs. 20-22; British Foss. Brach., III, 1871, p. 230, pl. XXXIII, figs. 22-28.

^aPal. N. Y., VIII, Pt. 1, pp. 192-194.

- Orthis lenticularis*? KAYSER, Palæontographica, Primordiale und untersil. Foss. Argentinischen Republik, II, 1876, p. 9, pl. I, figs. 11, 12.
Orthis lenticularis BROGGER 1882, Die Sil. Etagen, 2 und 3, p. 48.
Orthis lenticularis MATTHEW, Trans. Roy. Soc. Canada, IX, 1891, p. 46, pl. XII, figs. 9a-d.
Orthis lenticularis var. *strophomenoides* Matthew, Trans. Roy. Soc. Canada, IX, 1891, p. 49, pl. XII, figs. 12a, 12b.

Dr. George F. Matthew in his excellent review of the descriptions of this species gives a translation of Wahlenberg's original description, together with the Latin; also Dalman's, Leopold von Buch's, and Salter's descriptions.

He calls attention to the fact that if the reader will compare the several descriptions of this species by the authorities named he will be surprised at the diversity they exhibit. This diversity, Doctor Matthew thinks, is due partly to the imperfect descriptions of the earlier writers, but chiefly to the remarkable variability of the species.^a Doctor Matthew recognized the species in the Upper Cambrian, St. John, New Brunswick, and he also distinguished three varieties. Through Doctor Matthew's kindness I had the opportunity of studying the types of the varieties.

Through M. Schmalensee, collector of the geological survey of Sweden, I secured a large and fine series of this species from thin bands of limestone in the Olenus and alum shales at Olands and Nunneburg. I also collected a quantity of the shells from the Upper Cambrian of Manuels River, Newfoundland. From this material an attempt has been made to select a series illustrating the great range of variation in form and surface markings; first, from Sweden; second, Newfoundland, and third, New Brunswick. I was not able to obtain satisfactory material from Wales, but Mr. Davidson's figures illustrate fully the peculiarities of the species as it occurs there. These illustrations will appear in the completed monograph on the Cambrian brachiopoda.

Only one specimen was found in which the two valves were united. The convexity of the two valves is subequal, the ventral being a trifle greater.

A very careful search has been made of casts of the interior to illustrate the muscle scars and vascular markings. In a few instances traces have been found. One of these shows the area (pseudo-spondylium) beneath the umbo of the ventral valve; also the main vascular sinuses. Doctor Matthew illustrates some traces of the vascular markings and muscle scars, but they are almost too indefinite to be of value.

In a single specimen of the ventral valve from Olands, the cast of the umbonal cavity is nearly as sharp as in some specimens of *Plectorthis remmicha*. The cavity is tripartite, the central division being

^aTrans. Roy. Soc. Can., IX, 1891, pp. 46-47.

occupied by the diductor muscle scars, and the two lateral divisions are continuous with the ridges representing the casts of the main vascular sinuses. I have been unable to determine positively whether there is a deltidium present or not. The delthyrium is clearly shown in several specimens. Casts of the interior of the dorsal valve from Newfoundland show the presence of crural plates that extend to the bottom of the valve; also short, but very definite, crura and small depressions beside the latter for the reception of the teeth of the ventral valve. A cast of the ventral valve shows that the ventral plates extend to the bottom of the valve, and specimens from Sweden show that the dental plates and a transverse arching ridge sharply define, in certain individual ventral valves, the umbonal cavity.

The average size of the specimens from Olands is about 5 by 6 mm. One dorsal valve is 7 by 9 mm. Those from Nunneberg average from 5 to 6 mm., with occasional shells 7 by 8. In Newfoundland great numbers occur 4 by 5 mm., but there are also examples having a height of 10 mm., with a width of 12 mm. Doctor Matthew states that the medium size of the shell is about 5 by 6 mm. in the Acadian rocks. Doctor Brögger mentioned an example from Töien, Vestfossen, 10.5 by 12.5 mm.

I have not attempted any detailed description of the species, as it is so variable in form and surface markings. An attempt was made to discriminate varieties in the material from Sweden and Newfoundland, but there was such a gradation in all of the characters upon which such differentiation might rest that it was finally abandoned. Doctor Matthew considers that he has reason for establishing varieties among the New Brunswick forms. Whether these would be of value if a large amount of material were available for comparison is doubtful.

Dr. E. Kayser^a illustrates a shell that is apparently identical with *O. (O.) lenticularis*, which occurs in the sandstone at Tilcuya, Argentine Republic, in association with *Olenus*, *Agnostus*, etc. He also illustrates on Plate I, fig. 13, a dorsal valve of a small *Orthis* that in many respects looks more like *O. lenticularis* than figs. 11 and 12. I very much doubt if they represent this species; in fact Doctor Kayser questions his identification by an interrogation mark. He says of the shell:

Another much smaller *Orthis* species occurs in the fine-grained sandstones of Tilcuya, associated with *Olenus*, *Agnostus*, *Arionellus*, *Theca*, and *Orthis saltensis*, which has just been described. The smaller *Orthis* species is transversely oval in outline, with straight hinge edge, corresponding to the greatest breadth of the shell. The ventral valve is moderately arched, the dorsal somewhat less. The surface of both valves is covered with comparatively strong ribs, arranged in bundles. On the middle of the ventral valve there is an especially well-marked rib or bundle of ribs.

^a *Paleontographica*, Primordiale und untersil. Foss. Argentinischen Rep'b., p. 9, pl. 1, figs. 11, 12.

To it corresponds on the dorsal valve a well-marked sinus, limited on each side by a strong bundle of ribs.

The form just described agrees in the main so well with the figures given by Salter and Davidson of the small English form identified with Wahlenberg's *lenticularis*, that I can hardly doubt its specific identity with the latter.

Of *Orthis* sp. he remarks:

Before me lies a cast from Tilcuya, representing a third *Orthis* species. It is almost equal in size to *O. saltensis*, but differs from it by its outline, which is greatly prolonged transversely, the greatest breadth at the hinge edge, and the feebly wing-like projection of the hinge corners. This last-named characteristic and the much larger dimensions distinguish this fossil also from *O. lenticularis*. The surface of the shell has been covered with very strong bundles of ribs.

Formation and localities.—Upper Cambrian. Olenus schists, Nunneburg; Olands; alum shales, Andrarum; many localities in West Gotland, Sweden.

In Norway Doctor Brögger describes it from Vestfossen in association with *Peltura scarabæoides*.

In Wales it occurs at the following localities, according to Davidson.^a

Orthis lenticularis seems to be confined to the Upper Lingulaflags (Dolgelly groups of Belt, or upper portion of the Ffestiniog group of Sedgwick), and occurs at Penmorfa Church, near Tremadoc; near Criccieth, at Ogof-ddu Cliff, Swerny-y-Barcud, Rhiwfelyn, and in several other Welsh localities.

In New Brunswick Dr. G. F. Matthew states that it occurs in great numbers and all sizes in limestone lentiles, inclosed in the black shale of division 3a, at Germaine street, St. John.

In Newfoundland I found the separated valves covering the surfaces of shaly limestone, also in the body of the thin limestone layers, about 300 feet higher in the section than the zone of *Paradoxides hicksi*, Manuels River, Conception Bay.

The following varieties of *Orthis lenticularis* have been named by Doctor Matthew. I find essentially the same forms present in the collections from Sweden and Newfoundland. The variety *strophomenoides* does not appear to be of varietal value. Many such occur in the Swedish material.

ORTHIS (ORUSIA) LENTICULARIS ATRYPOIDES Matthew.

Orthis lenticularis var. *atrypoides* MATTHEW, Trans. Roy. Soc. Canada, IX, 1891, p. 48, pl. XII, figs. 11a, 11b.

Original description.—This form is comparatively smooth, though the ventral valve is sometimes concentrically wrinkled. This valve is distinguished by a median ridge and somewhat flattened sides, and the dorsal valve has an unusually deep sinus. Size of the known examples, 6 by 6 mm. and 5 by 6 mm. for the two valves.

Formation and locality.—Same as *O. lenticularis* in New Brunswick.

^a Brit. Foss. Brach., III, p. 232.

ORTHIS (ORUSIA) LENTICULARIS LYNCOIODES Matthew.

Orthis lenticularis lyncoioides MATTHEW, Trans. Roy. Soc. Canada, IX, 1891, p. 49, pl. XII, figs. 10a-c.

Original description.—Distinguished by its sharp, strong, radiating ribs, large umbo, and high cardinal area. In some of the larger examples the radiating ribs become subordinate to and are replaced on the newer part of the shell by concentric striae, reversing the usual position of the ribbed and the smooth parts of the shells of this species. Size of the valves, about 6 by 8 mm.

Formation and locality.—Same as *O. lenticularis* in New Brunswick.

ORTHIS (ORUSIA ?) EUREKENSIS Walcott.

Orthis eurekaensis WALCOTT, Mong. U. S. Geol. Survey, VIII, 1884, p. 22, pl. IX, fig. 8.

Protorthis ? eurekaensis HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 232.

Orthis ? eurekaensis SCHUCHERT, Bull. U. S. Geol. Sur. No. 87, 1897, p. 286.

General form rounded subquadrate; strongly convex. Surface marked by fine, rounded, radiating ribs, five in the distance of a millimeter. Length of ventral valve, 4 mm., width, 4.5; dorsal valve a trifle shorter.

Ventral valve with a high median fold over the umbo, that widens and flattens toward the front margin, which is arched to receive the projecting median depression of the dorsal valve. The umbo curves over to the apex, which overhangs the hinge line. Area low, and strongly inclined backward. The interior cast shows that there was a thick pseudospondylium, but no details of it are preserved. Dorsal valve with a deep, gently curved, median sinus or depression, that extends from the umbo to the front margin. In the cast strong anterior adductor muscle scars are shown on the sides of the median depression, and just back of them in the sinus what may be the smaller posterior adductor scars.

Observations.—This strongly-marked shell suggests some of the more convex shells of *O. (O.) lenticularis*; it differs in its fine ribs; deep median sinus of dorsal valve and sharp fold of ventral valve; also in the presence of a thickened shelf beneath the umbo of the ventral valve that suggests a spondylium; this character, however, is sometimes indicated in *O. (O.) lenticularis*.

Formation and locality.—Middle Cambrian. Prospect Mountain limestone just beneath Secret Canyon shale. East slope of Prospect Mountain, Eureka District, Nevada.

FINKELNBURGIA, new subgenus of, **ORTHIS**.

This subgenus is based upon two species that differ from *Plectorthis* in having thick shells and strongly marked vascular trunks in the ventral valve. The type of the subgenus, *F. finkelnburgi*, with its acuminate and sometimes alate cardinal extremities and subequally convex valves, is a very strongly marked type; the second species,

O. (F.) osceola, has obtuse cardinal extremities, and most of the examples closely resemble in form *Plectorthis remnicha*. It is only when the specimens from the fine-grained sandstone of Trempealeau are studied that one finds the thick shell and strong interior markings that are unknown in species of *Plectorthis*.

This subgenus is named after Mr. W. A. Finkelnburg, of Winona, Minnesota, who has been one of the most intelligent and enthusiastic collectors of Cambrian and Ordovician fossils in Minnesota in recent years.

The species referred to *Finkelnburgia* are—

Name.	Cambrian.		
	L.	M.	U.
1. <i>O. (Finkelnburgia) finkelnburgi</i> , new species			X
2. <i>O. (Finkelnburgia) osceola</i> , new species			X
<i>O. (Finkelnburgia) osceola corrugata</i> , new variety			X

ORTHIS (FINKELNBURGIA) FINKELNBURGI, new species.

Shell transverse with the cardinal angle extremities acuminate and in some examples almost alate. In the ventral valve the hinge line slopes toward the beak at a low angle; in the dorsal valve it is nearly straight. There is considerable variation in the height and width of the shell, this feature depending upon the extension of the cardinal angles. The convexity of the valves is subequal. In some examples the ventral valve is much more elevated and convex than in others, and the same is true of the dorsal valve. A low, clearly defined, mesial sinus occurs on the dorsal valve, being strongest in young shells, and there is frequently a flattening of the mesial area on the ventral valve.

The surface is marked by fine, rounded, radiating costæ, crossed by concentric lines, and, occasionally ridges of growth. In a ventral valve 7 mm. in height, 11 mm. in width, there are two costæ in a distance of 1 mm.

The largest specimen of a ventral valve in the collection has a height of 10 mm. with a width of 18 mm. The average shell is less than 8 mm. in height.

The cardinal area of the ventral valve is relatively high. It extends backward over the hinge line at an angle varying from 15° to 45° from the plane of the valve. The delthyrium is of moderate width and apparently partially covered by a deltidium. The cardinal area of the dorsal valve averages about one-half the height of that of the ventral valve, although in some shells it is fully two-thirds as high. It extends backward at an angle of about 70° to the plane of the valve. It is divided midway by a strong delthyrium. None of the specimens in the collections show whether there was a chilidium present or not.

In the interior of the ventral valve the strong teeth are supported

by dental plates that extend to the bottom of the valve and bound the umbonal cavity (pseudospondylium). The only traces of the vascular system are the bases of strong vascular trunks. The adductor muscle scars appear to have been carried into a very narrow space on an elevated ridge between the deep impressions made by the main vascular trunks; in another specimen the points of attachment of the muscles are well advanced into the valve.

In the interior of the dorsal valve a cast of the pseudocruralium appears to have a small, cardinal process, or callosity, but it is too doubtful to serve as basis for a statement that the cardinal process is present; there are traces of a median septum shown on the central ridge toward the center of the valve. The cardinal process occurs in the anterior half of the umbonal cavity. The casts of the interior show that the crura are short and well defined, with relatively strong dental sockets beside them. The only traces of the muscle scars observed are those of the adductor.

Observations.—The exterior surface and size of this shell recalls *O. (Finkelburgia) osceola*. It differs, however, in the acuminate ventral angles and strongly convex dorsal valve. In form the elongate cardinal angles relate this species to *Billingsella (Otusia) sandbergi*, but in surface and interior markings it materially differs from the latter.

Formation and locality.—Upper Cambrian. St. Croix sandstone at Trempealeau, Devils Lake, Osceola Mills, Wisconsin. Minneiska, Minnesota.

ORTHIS (FINKELNBURGIA) OSCEOLA, new species.

The general form of this species is similar to that of *P. remnicha*, except that it is usually more transverse. It is a smaller shell, averaging for the ventral valve a height of 8 mm. and width of 11 mm., while *P. remnicha* averages 12 mm. in height and 14 to 16 mm. in width in the adult shell. The radiating costæ are more uniformly rounded and regular and more numerous, except when compared with the variety *texana*. The shell of *O. (F.) osceola* is thick like other forms of the genus with a result that the vascular markings are definitely outlined. In one specimen the anterior and posterior diductor scars are beautifully shown; also the large main vascular sinuses so characteristic of many species of *Billingsella*. The adductor scars, cardinal process and median septum are well brought out in a cast. Some of the dorsal valves approach quite closely to those of *P. remnicha sulcata*.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Trempealeau; Menomonie, one-half mile southeast of court-house; Mazomanie; Osceola Mills; Lodi, about one-third of a mile west of railroad station, Wisconsin. Just below *Dicellocéphalus minnesotensis* bed, Winona, Minnesota.

ORTHIS (FINKELNBURGIA) OSCEOLA CORRUGATA, new variety.

At two localities of *O. (F.) osceola* a few specimens occur which have strong concentric ridges formed by the piling up of lines of growth. The shell has a corrugated appearance that is very distinctive and it is designated as a variety.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Osceola Mills, Wisconsin. Just below *Dicellocyphalus minnesotensis* beds, Winona, Minnesota.

PROTORTHIS Hall and Clarke.

Protorthis HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 231, pl. VII A, figs. 14-21; Eleventh Ann. Rep. State Geologist New York, p. 273, pl. VIII, figs. 3-7.

Billingsella SCHUCHERT, Bull. U. S. Geol. Sur. No. 87, 1897, p. 334.

Original diagnosis.—Shells small, transversely subquadrate or semicircular. Hinge-line straight, its length being equal to the greatest width of the valves. Valves unequally biconvex, or subplanconvex, the pedicle-valve being the larger. The cardinal area is narrow on both valves, but is higher on the [ventral] pedicle-valve, and is transected by a broad delthyrium, which is closed below by a concave plate apparently produced by the union of the dental lamellæ, which are not continued to the bottom of the valve; teeth distinctly developed. In the [dorsal] brachial valve the cardinal area also bears an open delthyrium; the dental sockets are obscure and the crural plates small; the latter appear to unite and form a low elevation across the base of the delthyrium. Cardinal process absent or rudimentary in all the specimens examined. Muscular markings in both valves extremely obscure.

Surface marked by distinct plications, with interstitial finer radii, which are crossed by delicate concentric striae; these are usually accompanied by a low sinus and fold on the brachial and pedicle-valves, respectively; interior very finely papillose. Shell-substance fibrous and apparently punctate.

Type.—*Orthis Billingsi* Hartt. St. John group.

The characters of the St. John species are eminently comprehensive; first, the form of the shell is one more frequently met with among the strophomenids than among the orthids; the concave plate formed by the union of the dental lamellæ is never found in *Orthis* proper, though occurring in *Scenidium*. In *Orthisina* or *Clitambonites* this plate is always present, but always supported by a median septum and invariably accompanied by the convex deltidium, which, so far as known, does not exist in *Protorthis*; while in the group typified by *Orthis Pepina*, Hall (here designated by the term *Billingsella*), the convex deltidium of *Clitambonites* is present and the concave or dental plate absent. The apparent absence of a cardinal process in *Protorthis* may be due to the imperfections of the fragile shells studied. The specimens of the St. John shells are preserved as external and internal casts, and from some of these there is reason to infer that the substance of the shell was punctate.

Observations.—A study of the various species here described under the genus *Protorthis* has not given data that will add to the above generic description. All of the species have evidence of punctæ of greater or less depth on the inner and outer surfaces of the shell, but in none of them have punctæ been found that penetrated through the shell; this may be owing to the fact that all of the species are pre-

served as casts in the sandstone or shale, and none of them have the original shell substance, or a calcareous or siliceous replacement of it.

A careful examination of a large number of specimens of the dorsal valve fails to reveal a true cardinal process.

The genus ranges from the Middle Cambrian well up into the Upper Cambrian. The Middle Cambrian species are: *Protorthis billingsi*, *Protorthis latourensis*, *Protorthis nautes*, *Protorthis quacoensis*, *Protorthis spencei*. Upper Cambrian: *Protorthis? nunnebergensis*, *Protorthis wingi*, *Protorthis*, species undetermined.

The subgenus *Loperia* has one species *P. (L.) dougaldensis* from the Middle Cambrian.

PROTORTHIS BILLINGSI Hartt.

Orthis billingsi HARTT, Acadian Geology, Dawson, 1868, 2d ed., p. 644, fig. 223.

Orthis billingsi WALCOTT, Bull. U. S. Geol. Survey No. 10, 1884, p. 17, pl. I, fig. 1, 1a-d.

Orthis billingsi MATTHEW, Trans. Roy. Soc. Canada, III, 1886, p. 43.

Orthis? billingsi MATTHEW, Trans. Roy. Soc. Canada, VIII, 1891, p. 131.

Protorthis billingsi HALL and CLARKE, Pal. N. Y., VIII, Pt. 1, pp. 219, 232, pl. VII A, figs. 14-20; Eleventh Ann. Rep. State Geologist, New York, 1892, p. 273, pl. VIII, figs. 3-7.

Billingsella billingsi SCHUCHERT, Bull. U. S. Geol. Sur., No. 87, 1897, p. 158.

The generic description follows very closely that of the type species *P. billingsi* in its main features. All of the specimens are compressed in the embedding shale, which renders it difficult to get a true conception of the convexity and forms of the valves. The outlines may be transversely quadrilateral or subsemicircular or subquadrate. Usually the area is inclined backward over the hinge line, but it may be distorted by pressure so as to appear to incline forward. Young shells have a well-defined median sinus on the ventral valve that shows as a flattened space on the larger shells. A slight sinus sometimes appears on the dorsal valve. The surface of the shell varies in the number and size of the radiating ribs; sometimes they are scarcely visible toward the cardinal margin, and in other shells they are clearly defined all over the surface; the increase in number is by bifurcation and interpolation; fine, thread-like concentric striæ and strong squamose lines of growth cross the ribs.

Ventral valve moderately convex, with the umbo and apex slightly curved over the area or erect above the area. Area appears to be slightly concave, divided midway by a triangular delthyrium, which is more or less closed by a concave plate that Hall and Clarke consider to be formed by the uniting of an extension of the dental plates or lamellæ; from the casts it appears that the teeth were well developed and supported by dental plates that united at the center opposite the delthyrium, but did not reach the bottom of the valve or a median septum; the free spondylium varied in length from a narrow rim

opposite the head of the delthyrium to a plate two-thirds or more of the length of the delthyrium.

Dorsal valve uniformly and moderately convex, with the apex curved over to the edge of the low area; area divided by a broad delthyrium; casts of the interior show that the crura were strong, dental sockets shallow, and that the crural plates extended across the umbonal cavity, uniting to define what may be called a pseudocurialium. No trace of a cardinal process has been seen in a large number of casts of the interior, and Messrs Hall and Clarke did not find any in a large amount of material.

The casts of the interior show that the shell was minutely punctate, and a shell preserving some of the inner layers has every appearance of punctate structure,

Observations.—This species differs from all recognized species of the genus by its surface ribs and striae.

Formation and locality.—Middle Cambrian. Paradoxides zone. Dark argillaceous shales of division 1c, Seeley street, St. John, Portland Brook and Ratcliffs Millstream, New Brunswick.

PROTORTHIS HELENA, new species.

This species is founded on the cast of a ventral valve associated with *Protosiphon kempianum*. The form of the spondylium and area is like that of *Protorthis latourensis*, but the smooth shell with a broad, rounded mesial sinus is unlike that species and also other species of the genus. The shell appears to have been thicker than that of *P. latourensis*. Only traces of growth lines are preserved on the cast. The ventral valve is 10 mm. long with a width of 14 mm. The cast shows that the teeth and dental plates were unusually strong.

This species differs from all others of the genus by its smooth or nearly smooth surface and strong median sinus. It suggests *Syntrophia barabuenensis* at first sight, but there is no evidence of a median septum supporting the spondylium.

The specific name is that of Mrs. Walcott who collected the specimen.

Formation and locality.—Middle Cambrian. St. John formation, Kennebecasis River, St. John County, New Brunswick.

PROTORTHIS LATOURENSIS Matthew.

Kutorgina latourensis MATTHEW, Trans. Roy. Soc. Canada, III, 1886, p. 42, pl. v. figs. 18, 18a-c.

Kutorgina latourensis HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, pp. 93, 95, 233, pl. iv, figs. 18, 19, 20.

Original description.—Valves narrowly semicircular, broader than long, flat; umbones low; greatest thickness in the posterior third; hinge line shorter than the width of the shell.

Dorsal valve with a distinct median depression extending from the umbo to the front margin, and with low ridges diverging from the beak toward the lateral third of the front of the valve. Umbo not elevated above the hinge area, which is exceed-

ingly narrow or absent. Hinge line with two sharp, slightly projecting teeth near the umbo [crura?].

Ventral valve with a narrow median ridge extending two thirds of the length of the valve toward the front margin; also with a fainter ridge on each side diverging toward the lateral third of the border of the valve; umbo very low; hinge area perceptible but very narrow, longitudinally striated, and having a minute tooth on each side of the very narrow and small foraminal opening.

Surface ornamented with about forty or fifty fine, faint, radiating striae; those of the middle fifth are close, continuous, and straight; a few on each side of these are more divergent, while those near the beak of the shell are fainter, closer than the last, and moderately arched outward toward the lateral borders. The surface of the valves is also marked by very fine but distinct concentric striae; and at somewhat regular intervals by about twelve more distinct lines of growth. The concentric striae are usually as distinct as the radiating. Casts of the interior of the valves exhibit a smooth surface with some irregular, sinuous, radiating striae.

Length 7 mm., width 11 mm. Length of hinge line, 8 mm.

Observations.—Doctor Matthew kindly sent me the types and cotypes of this species, and from them and collections in the United States National Museum, sufficient data was obtained to clearly show that his opinion that the species belong to *Protorthis* and not *Kutorgina* was correct. As far as known the characters of the area, teeth and free spondylium are the same as in *P. billingsi*. The smooth casts suggest *Kutorgina*^a but the ribbed shells recall *P. quacoensis* and the area with open delthyrium and free spondylium place the species in *Protorthis*. Its very fine surface ribs differentiate *P. latourensensis* from all other described species.

Formation and locality.—Middle Cambrian. St. John shales, division 1c, Portland, New Brunswick.

PROTORTHIS LÆVIS, new species.

Ventral valve transversely semicircular, moderately convex; surface of cast smooth; area overhanging the hinge line at about 30° from the plane of the margin of the valve. The cast shows a very clearly defined free spondylium. Shell about 6 mm. in width and 4 mm. in length.

This is the only representative of the genus known outside of the Atlantic basin Cambrian fauna. All other species occur in New Brunswick and Cape Breton. Its smooth surface and inclined area distinguish it from other species of the genus.

Formation and locality.—Middle Cambrian. St. Croix sandstone, one-half mile southeast of county court-house, Menominee, Wisconsin.

PROTORTHIS NAUTES, new species.

This species has the same type of punctate interior surface as *P. billingsi*, and casts of the exterior are marked by minute, closely set papillae that are casts of the punctae in the shell. Traces of the shell show the same type of papillae. It is highly probable that the shell

^aSee figures 18–20, Pal. N. Y., VIII, Pt. 1, pl. IV.

was punctate. The exterior form is like that of *P. billingsi*, but in the surface ribs it differs from the latter and other described species of the genus.

A ventral valve has a length of 5 mm.; width, 8 mm. A dorsal valve, length, 7 mm.; width, 10 mm. There is considerable variation in the relative proportions between length and width.

Formation and locality.—Middle Cambrian. Dark argillaceous shales, Wasatch Range, near Montpelier, Idaho.

A similar shell occurs in the shaly limestone of the Middle Cambrian, 3 miles east of Antelope Springs, Utah.

PROTORTHIS (?) NUNNEBERGENSIS, new species.

Shell transversely semielliptical, plano-convex. Surface with very fine ribs that increase by interpolation and bifurcation; on some shells bands of slender ribs are delimited by stronger ribs, usually 2 to 5 between 2 more prominent ribs; fine concentric striae give a crenulated aspect to the radiating ribs. Casts of the interior and exterior appear to be minutely papillose, indicating punctae in the shell.

Ventral valve moderately convex, with the apex curved down to the margin of the area; area and interior unknown. Dorsal valve flat or very slightly concave between the umbo and margins; apex slightly elevated above the plane of the surface and cardinal line; a median sinus is present in some shells.

Observations.—It is a little hazardous to refer this species to *Protorthis*, as only the general form and surface are known. The nearly plano-convex valves and surface relate it more nearly to *Protorthis* than *Plectorthis*, and it does not appear to fall within *Leptaena*, *Rafinesquina*, or *Strophomena*. The specimens were collected by Mr. Von Schmalensee in a dark, argillaceous shale above the Ceratopyge limestone and below the lower graptolite shale.

Formation and locality.—Upper Cambrian. Mossebo, Nunneberg, Vestergotland, Sweden.

PROTORTHIS QUACOENSIS Matthew.

Orthis quacoensis MATTHEW, Trans. Roy. Soc. Canada, III, 1886, p. 43, pl. v, figs. 20, 20a-c.

Orthis ? quacoensis MATTHEW, Trans. Roy. Soc. Canada, VIII, 1891, p. 131.

Protorthis quacoensis HALL and CLARKE, Pal. N. Y., VIII, Pt. 1, p. 232, pl. VII A, fig. 21.

Billingsella quacoensis SCHUCHERT, Bull. U. S. Geol. Sur., No. 87, 1897, p. 159.

Original description.—A small species. Subquadrate to semielliptical in outline, broader than long, widest near or at the hinge line, which is not produced; moderately convex, highest in the posterior third, flattened toward the front and sides. Umbones not prominent.

The dorsal valve rises rapidly from the hinge line, and has but a narrow, flattened space at the angles. It is about one-third as high as it is long. The hinge plate has a narrow area, which is striated lengthwise, and bears two tooth-like processes close to the umbo, the point of which is bent down to the hinge line.

The ventral valve is somewhat more elevated than the dorsal. Hinge area triangular, sloping backward to the umbo, and bearing fine striæ parallel to the hinge line. Umbo elevated above the hinge line to a height fully equal to one-third of the length of the valve. Foramen [delthyrium] large, truncate-pyramidal in outline.

Surface of the valves ornamented by about twenty rounded plicæ, radiating [in the ventral valve] from the edge of the hinge area, opposite the foramen [delthyrium] and not from the beak alone; those on the middle fifth of each valve are crowded together, those outside of these are more prominent, and are continuous from the umbo; those toward the hinge line are faintly marked and widely separated. The radiating plicæ do not [or rarely] increase by bifurcation. Both valves bear numerous concentric striæ, and are also marked by a few distinct squamose lines of growth.

The mold or cast of the interior of the valves of this species is nearly smooth or is marked by faint radiating striæ; the margin of the mold, however, often exhibits a crenulated appearance corresponding to the plicæ of the outer surface. There is a wide, smooth median depression at the top of the mold of the dorsal valve near the umbo.

Length of the valve in *O. quacoensis*, 5 mm.; width, 8 mm.

Observations.—Doctor Matthew very kindly sent me his types of this species. A comparison of them with *P. billingsi* shows that the two species are quite distinct, and *P. quacoensis* is unlike any other shell referred to the genus.

As far as seen the free spondylium of the ventral valve is short; the teeth are clearly shown in the cast. The pseudo-cruralium of the dorsal valve is much more clearly defined than in *P. billingsi*, the area is higher, and traces of the adductor muscle scars are preserved.

Formation and locality.—Middle Cambrian. Paradoxides zone, division 1c, Portland and at Porter's Brook, St. Martins, New Brunswick.

PROTORTHIS SPENCEI, new species.

This is a strongly marked species despite the fact that only a few specimens have been found, and these are flattened in the shale. It is distinguished by its rounded, subquadrate outlines and narrow, sharp ribs with strong interspaces—six ribs in a distance of 5 mm. at the front margin. The area of the ventral valve has a broad delthyrium with a concave plate or free spondylium, covering the greater part of it. The interior surface of the shell is finely punctate. A flattened ventral valve has a length of 17 mm.; width, 18 mm.

This shell is associated with *P. navtes*. It differs from it in its larger size, sharper ribs, and broader interspaces between the ribs.

The species is named for Mr. R. S. Spence, of Montpelier, Idaho, a gentleman who made large collections from the Middle Cambrian shales of Idaho.

Formation and locality.—Middle Cambrian. Argillaceous shales, Wasatch Range, near Montpelier, Idaho. Shaly limestones, 3 miles east of Antelope Springs, House Range, Utah.

PROTORTHIS WINGI, new species.

General form transversely subelliptical. Surface marked by about 20 sharply ridged ribs with interspaces equal and usually greater than the width of the rib; shell with numerous small and many larger and scattered punctæ on the inner and outer surfaces. The largest ventral valve has a length of 6 mm.; width, 9 mm.

Ventral valve convex, elevated at the umbo and beak; area high and divided midway by a strong delthyrium which is partially closed by a concave free spondylium as in *P. billingsi*, teeth strong, dental plates extended toward the center to unite and form the free spondylium.

Dorsal valve slightly convex, with a broad median sinus that is usually bounded by one or two large ribs; casts of the interior show a narrow area, broad delthyrium, and the cast of a small, broadly triangular, elevated area opposite the umbo that probably served as the cardinal process for the attachment of the diductor muscles.

Observations.—This species is most nearly related to *Protorthis nautes*; it differs, as far as known, in the character of the interior of the dorsal valve, the large punctæ scattered among the fine punctæ, and the sharp ridged ribs. One cast of an interior of a ventral valve appears to indicate that that shell was without the free spondylium. It not infrequently occurs in *Protorthis billingsi* that the free spondylium is reduced to a narrow rim about the margin of the delthyrium, and it may be that in this shell it was absent.

The specific name is given in memory of Rev. Augustus Wing, who did so much excellent work in the vicinity of Swanton, Vermont, which was utilized by Mr. Billings and Sir William E. Logan.

Formation and locality.—Upper Cambrian. Dark argillaceous shales, about one-half mile south of Highgate Falls, Vermont.

PROTORTHIS, species undetermined.

Ventral valve convex, elevated at the umbo, apex incurved. The cast of the umbonal cavity (pseudospondylium) indicates well developed teeth and dental plates. On the cast 6 radiating ribs occur in the distance of 1 mm.; area about vertical. The surface of the cast indicates that the interior layer of the shell was finely punctate. Length of valve 4.5 mm., width 5.5 mm.

Only one specimen of a cast of a ventral valve of this shell was found. It suggests by its convexity and surface some of the more convex forms of *Protorthis quacoensis*.

Formation and locality.—Upper Cambrian. Tonto terrane. Thin bedded siliceous limestone at mouth of Kanab Canyon, Grand Canyon, Arizona.

LOPERIA, new subgenus of **PROTORTHIS**.

This subgenus is characterized by the form of the valves. The ventral valve is elevated at the umbo and flat or slightly concave from the umbo to the margins; the dorsal valve is strongly and regularly convex. The description of the type species, *Protorthis* (*Loperia*) *dougaldensis*, is that of the subgenus and species, as it is the only species thus far known of the subgenus.

PROTORTHIS (LOPERIA) DOUGALDENSIS, new species.

General form rounded subquadrate. Hinge line straight and shorter than the greatest width of the shell; cardinal extremities obtusely angular. Relative convexity of the valves reversed, as in *Dinorthis pectinella* of the Ordovician fauna. Surface of the dorsal valves with strong, simple, rounded ribs that increase by interpolation; fine concentric striae and lines of growth that sometimes form ridges, cross the ribs, curving in the interspaces and over the ribs; these ribs are more prominent and numerous (30 to 40) on the dorsal than on the ventral valve; on the latter the ribs are broad, with narrow interspaces, and about 20 to 25 in number; casts of the exterior and interior surfaces have numerous fine, thickly set, elevated papillae that appear as the casts of the punctae in the layers of the shell; on some specimens the papillae are cylindrical and elevated, which indicates that they penetrated deep into the shell substance. All indications point to a punctate shell; in all the material representing the species the shell has been removed by solution, only the casts of the inner and outer surfaces remaining.

The largest ventral valve in the collection has a length of 18 mm., width 25 mm.; dorsal valve, length 22 mm., width 27 mm.

Ventral valve elevated at the umbo and gently concave from the umbo to the front margin and flat to the cardinal extremities. Area relatively low and overhanging the hinge line at an angle of about 45°; it is divided midway by a broad delthyrium that is more or less closed by a deeply concave plate, across which the transverse striae of growth of the area pass. The concave plate appears to be identical in form and position with the free spondylium of the genus *Protorthis*. A cast of the interior shows very strong teeth and supporting dental plates; the edges of the dental plates appear to be continuous with the concave plate or free spondylium.

Dorsal valve strongly and regularly convex, with a slight flattening of the median line and sometimes a shallow sinus. Casts of the interior show a strong area with a triangular delthyrium; the umbonal cavity is strongly outlined by the crural plates so as to form a pseudocruralium; crura well developed, with clearly defined teeth sockets back of them. No traces of a cardinal process have been seen in ten

specimens showing fine casts of the area, delthyrium, and umbonal cavity.

Observations.—This fine species is unique among Cambrian brachiopods in having a depressed, flat, or convex ventral valve and strongly convex dorsal valve. In its punctate shell, free spondylium, and absence of cardinal process, it is allied closely to *Protorthis*; the depressed ventral valve and convex dorsal valve serve to distinguish it as a subgenus of *Protorthis*, which I have called *Loperia* in recognition of the effective work of Mr. S. Ward Loper, who collected the material representing this and many other Cambrian fossils in Cape Breton and New Brunswick.

Formation and locality.—Middle Cambrian. Division 2—probably 2b—of Matthew's section. Dougald Brook, tributary to Indian River; one-fourth mile from lower bridge, Escasonia, Cape Breton, Nova Scotia.

SYNTROPHIA Hall and Clarke.

Syntrophia HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 270; 1893, Pt. 2, p. 216; Thirteenth Ann. Rep. State Geol. N. Y., 1895, p. 836.

Original description.—Shell transversely elongate, biconvex, with straight hinge-line, whose length nearly equals the greatest diameter of the valves; each valve medially divided by an open delthyrium. External surface smooth, with fine concentric lines visible only about the margins; the inner shell-layers show a strongly fibrous radiating structure without punctation. The pedicle valve bears a more or less clearly developed median sinus and the brachial valve a broad, indistinct fold.

On the interior the teeth are very small, lying at the extremities of the delthyrial margins and supported by dental plates, which converge and unite before reaching the bottom of the valve. Thus is formed a deep but short spondylium, which is supported, near its apical portion, by a median septum, but is free for fully one-half its length.

In the brachial valve there are also two convergent plates bounding the deltidial cavity, larger and stronger than those of the opposite valve. These plates may rest upon the bottom of the valve and, toward the posterior extremity, probably always do; but anteriorly they become free, forming a spondylium, which is supported by a median septum extending beyond the anterior edge of the plate. Thus these two valves, which are very similar in exterior, the pedicle-valve being only slightly the more convex and with a low median sinus, are also closely alike on the interior, each being furnished with a spondylium.

Type.—*Syntrophia lateralis*, Whitfield (sp.).

Observations.—Messrs. Hall and Clarke referred *Orthis barabuenensis* and *Triplesia primordialis* among Cambrian species to *Syntrophia* and of Ordovician species, *Triplesia lateralis*, *Stricklandinia ? arethusa*, *S. ? arachne* and *Camarella calcifera*.

Orthis ? armata Billings, of the Lower Ordovician, certainly has a close resemblance in the spondylium of the ventral valve to this genus, and it may represent a radially striated form, as suggested by Messrs. Hall and Clarke.^a Of the relations of the shells referred to *Syn-*

^a Pal. N. Y., VIII, Pt. 2, p. 218.

trophia, to *Stricklandinia*, they consider that the points of structure may represent the structure which is represented by the *Stricklandinias* of the later Silurian and Devonian. Mr. Billings noted the relationship existing between his *Camarella calcifera* and *Stricklandinia*.^a It is probable that *S. arachne*, *S. arethusa*, and similar forms should be referred to a distinct genus. They are not typical *Stricklandinias*, and they differ in surface and shape from *Syntrophia lateralis*.

The Cambrian type of *Syntrophia* is *S. rotundatus* of the Upper Cambrian. It has a spondylium in each valve supported by a median septum, and a short area divided by a large open delthyrium.

The Middle Cambrian species, *S. texana*, and Upper Cambrian species, *S. abnormis* differ from the type species in having the greater portion of the bottom of the spondylium of each valve attached to the bottom of the valve, no evidence of median septum having been found except in a cast of a dorsal valve. *S. primordialis* has no median septum in the dorsal valve, in this respect resembling the dorsal valve of *Camarella volborthi*. There is considerable variation of form in the different species, but this is not much greater than the varieties of the type species, *S. lateralis*.

The species referred to the genus may be divided into two groups, the plicate and nonplicate. The plicate species begin with *S. texana*, and includes *S. abnormis*, *S. orientalis*, and *S. billingsi*, all of the Upper Cambrian. The nonplicate or smooth species are *S. alata*, *S. rotundata*, *S. barabuenensis*, and *S. primordialis*, of the Upper Cambrian, and *S. calcifera*, *S. lateralis*, *S. nudina* and allied forms, of the Ordovician.

SYNTROPHIA ABNORMIS, new species.

Camarella calcifera MEEK, Sixth Ann. Rept. U. S. Geol. Sur. Terr., 1873, p. 464.

The general form varies from transverse to elongate. Valves biconvex, with dorsal very convex in some specimens. Hinge line straight. Surface marked by concentric striæ and imbricating lines of growth crossed by fine, rounded, radiating striæ and a variable number of rounded ribs; specimens occur with four ribs in the sinus of the ventral valve and four on each slope outside the sinus; in other ventral valves only a trace of ribs can be seen. On the dorsal valve there are shells without a sign of ribs, and others with a trace of rib on the median fold to three ribs on the fold and traces on the lateral slopes. The largest shell has a length of 7 mm.; width 9 mm.; there is great variation in the proportion of the length to the width.

The ventral valve has a broad, strong sinus that depresses the front of the valve; area well defined, with a large, open delthyrium. Casts of the interior of the ventral valve show a well-marked spondylium

^a Pal. Foss., I, p. 84.

and very strong main vascular sinuses; both spondylium and sinuses recall those of *Billingsella plicatella*. Sections of the ventral valve cut across the umbo show the spondylium attached to the bottom of the valve. The flabelliform diductor and adductor muscle scars are clearly shown outside of the vascular sinuses.

Dorsal valve with an elevated median fold that gives a strong convexity to the valve; area low, with a strong, open delthyrium; the interior of the valve shows a shallow spondylium attached to the bottom of the valve posteriorly, and probably supported by a low median septum toward the front, and well defined anterior and posterior adductor muscle scars; narrow main vascular sinuses occur, and slender vascular lines radiate forward from the muscle scars.

Observations.—This species differs from all allied forms by its variation in outline, convexity, ribs and internal markings. Some shells approach closely to those of *S. terana*, but each species has a majority of shells that are quite unlike those of the other. Another point of resemblance is the form of the spondylium as shown by cross sections. A variety of *S. terana* from Cold Creek Canyon, Texas, has some shells that approach those of *S. abnormis* in the extravagant development of the fold on the dorsal valve and sinus on the ventral valve, but in other respects they differ from it. The form of the spondylium and plications or ribs, suggests the genus *Parastrophia* Hall.

Formation and locality.—Upper Cambrian. Head of Deep Creek Yellowstone National Park, Wyoming. North of East Gallatin River, near Hillsdale, Dry Creek, Gallatin Valley, Montana.

SYNTROPHIA ALATA, new species.

This species is characterized by its transverse form and extended cardinal angles. Exterior surface marked by concentric striae and lines of growth and interior surface by fine, radiating striae. A transverse section of the ventral valve at the umbo shows the spondylium with a strong median septum supporting it. The interior of the ventral valve was marked by two strong main vascular sinuses starting from the sides of the spondylium.

Formation and locality.—Upper Cambrian. Honey Creek, Burnett County, Texas.

SYNTROPHIA BARABUENSIS A. Winchell.

Orthis barabuensis A. WINCHELL, Am. Jour. Sci., 2d ser., XXXVII, 1864, p. 228.

Leptæna barabuensis WHITFIELD, Ann. Rep. Geol. Survey Wisconsin, 1877, p. 60.

Leptæna barabuensis WHITFIELD, Geology of Wisconsin, IV, 1882, pp. 171, 195, pl. I, figs. 6, 7; pl. III, fig. 6.

Syntrophia barabuensis HALL and CLARKE, Pal. New York, VIII, 1893, Pt. 2, p. 216.

Description (by Mr. Whitfield).—Shell of medium size or smaller, measuring about half an inch or less than half an inch along the hinge line; form semielliptical, longest on the hinge and more than half as wide again as long; extremities of the hinge

often submucronate; front of the valves rounded or slightly emarginate in the middle. Ventral valve the most convex, and marked by a strong, angular mesial elevation, nearly one-fourth as wide on the front of the valve as the width of the shell; area moderately high and nearly in the plane of the valve; cardinal borders very gradually sloping from the center to the extremities of the cardinal line. Dorsal valve less convex than the opposite, and marked by a subangular mesial depression, corresponding to the fold of the opposite valve; area linear. Surface of the shell apparently smooth, or at least so far as can be determined from either the internal casts or from the matrix.

I had some doubt regarding the positive identity of this species with that described by Professor Winchell in consequence of the following remarks which occur in his description: "Surface with 16 or 18 ribs visible on the casts, the strongest of which limit the mesial sinus," and again, "apparently of the type of *Orthis biforta*." In examining a number of specimens I had not been able to detect any striae or ribs, and felt somewhat inclined to regard it as a distinct species from that one. I have, however, through the kindness of Professor Winchell, been able to make a direct comparison with one of his original specimens, and should consider them as identical. The specimen sent me has the mesial fold (of the ventral valve) remarkably strongly defined by a depressed line on each margin, the center appearing tumid, which I think is in part due to accident. The specimen corresponds closely with the ventral valve we have figured, except in the strongly defined mesial fold.

Observations.—This is the same type of *Syntrophia* as *S. primordialis*. It differs in its more rounded outlines, shallow, rounded sinus in ventral valve, and usually a less pronounced fold on the dorsal valve. Evidence of a short median septum at the end of a very short spondylium in the dorsal valve is shown by one cast.

Formation and locality.—St. Croix sandstone, north end of Devils Lake near Baraboo and Trempealeau, Wisconsin.

SYNTROPHIA BILLINGSI, new species.

General form transversely subquadrate; rounded; biconvex, with the dorsal valve elevated on the median fold. Surface marked by a few imperfectly developed ribs on some shells, while others have only concentric striae and lines of growth. Ventral valve with a relatively shallow median sinus, in which obscure, narrow ribs sometimes occur; none of the specimens in the collection show the area, but from the profile of the valve it must have been of moderate height, with the rather sharp apex curving slightly over it; a single poor cast of the interior shows the outline of a spondylium much like that of *S. primordialis*; the evidence of the presence of a median septum is a dark line in front of the end of the cast of the spondylium, which indicates that the shell substance extends down into the limestone and that it is the median septum. Dorsal valve with a small umbo and apex that extends forward into a prominent median fold that may be plicated or smooth; one partially exfoliated shell shows three plications on the fold and three or four on each lateral slope of the valve.

Observations.—This species belongs to the plicate group of the genus represented by *S. texana* and *S. abnormis*. It differs from *S.*

texana in being less convex and in having a shallower ventral sinus, less prominent dorsal fold, and more obscure plications.

The specific name is given in memory of Elkana Billings.

Formation and locality.—Upper Cambrian. In lentile of limestone interbedded in silicious shales above the Olenellus shales, 1 mile east of Parker's quarry, Georgia Township, St. Albans County, Vermont.

SYNTROPHIA NUNDINA, new species.

Tripllesia calcifera WALCOTT, Mong. U. S. Geol. Sur., VIII, 1886, p. 75, pl. II, figs. 7, 8.

The nonplicate, convex species that is found in the Lower Ordovician of the western United States has usually been referred to *Camerella* or *Tripllesia calcifera*. It is much like the latter, but differs in being less convex, with apex of valves less pointed and incurved.

Formation and locality.—Lower Ordovician. Pogonip formation. Spur on ridge extending out southwest from Wood Cave; lower eastern slope of ridge, east of Hamburg Ridge, facing Secret Canyon road; west side of Goodwin Canyon; base of Pogonip limestone north-east of Adams Hill, Eureka District, Nevada.

Pinkish colored limestone 30 to 75 feet above Algonkian rocks, Williams Canyon, above Manitou, Colorado.

SYNTROPHIA ORIENTALIS, new species.

This species is closely related in form and surface characters to *Syntrophia texana* and some forms of *S. abnormis*. It differs from them in details of surface ribs. On the dorsal valve there are two or three faintly defined radiating ribs on each side of the median fold, which has obscure ribs upon it. Corresponding ribs occur upon the mesial depression of the ventral valve and the side slopes adjoining the depression. The material representing it is too limited to warrant an identification with any described species. *S. orientalis* is the trans-Pacific representative of *S. texana*.

Formation and locality.—Upper Cambrian. Lower part of Chao Mi Tien (?) limestone, 2.7 miles southwest of Yen Chuang, Province of Shantung, China. Collected by Eliot Blackwelder and Bailey Willis of the Carnegie Institution Expedition, 1903.

Syntrophia, sp.—Three specimens of a ventral valve, very much like that of *S. primordialis* Whitfield, occur at the same locality as *S. orientalis*.

SYNTROPHIA PRIMORDIALIS Whitfield.

Tripllesia primordialis WHITFIELD, Ann. Rep. Geol. Surv., Wisconsin, 1877, p. 51.

Tripllesia primordialis WHITFIELD, Geology of Wisconsin, IV, 1882, p. 172, pl. x, figs. 1, 2.

Tripllesia primordialis HALL, Pal. New York, VIII, 1892, Pt. 1, p. 271.

Syntrophia primordialis HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 2, p. 218.

Original description.—Shell small, measuring less than half an inch in width; transversely oval in outline, and quite ventricose in profile; hinge line straight and about

half as long as the width of the shell below; area narrow. Ventral valve with a strongly depressed, rather narrow and rounded mesial sinus. Dorsal valve with a narrow, sharply elevated fold not extending quite to the beak; side of the valve rounded. Surface smooth in the casts, but presenting the appearance of having been externally striate. Processes in the interior of the dorsal valve apparently forming a small spoon shaped pit at the beak.

Observations.—Casts of the interior show the form of the spondylium and supporting median septum in the ventral valve; also the small, short spondylium in the ventral valve, which appears to be attached to the bottom of the valve without a median septum.

This species differs from *S. barabuiensis* in its smaller size, less transverse outline, and more pronounced mesial depression on the ventral valve. Examples occur of the dorsal valves of the two species that are very similar. Some of the shells approach certain forms of *S. calcifera*, but the larger number are less convex and more transverse and with more obtuse cardinal angles. A shell closely allied to *S. primordialis*, and apparently identical, occurs in the Reagan limestone. Only the exterior is known.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Taylors Falls, Adams County, Wisconsin. Abundantly at Minneiska, and more rarely at River Junction, Houston County, and near Winona, Minnesota.

Numerous examples of a closely related shell occur in the upper part of the Reagan limestone in the SE. corner, NE. $\frac{1}{4}$ sec. 2, T. 4 N., R. 13 W., 15 miles northwest of Fort Sill, Wichita Mountains, Oklahoma Territory.

A single ventral valve of the nonplicate shell with a deep sinus comes from the Upper Cambrian, Reagan limestone, Indian Territory, NW. $\frac{1}{4}$ sec. 1, T. 2 S., R. 1 E. Specimens of the ventral valve of a shell apparently identical with *S. primordialis* occur in the limestone passage beds between the Upper Cambrian and Ordovician on the north side of Tepee Creek, east side of Big Horn Mountains, Wyoming.

SYNTROPHIA PRIMORDIALIS ARGIA, new variety.

This specimen is separated as a variety of *S. primordialis* on account of its less convexity and more shallow median sinus which has three rudimentary plications in it.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Reeds Landing, foot of Lake Pepin, Minnesota.

SYNTROPHIA ROTUNDATA, new species.

General form rotund, unequally biconvex; hinge line short. Surface marked by fine, concentric striae and low, imbricating varices of growth. The longest shell observed has a width of 13 mm.; length 11 mm. Ventral valve convex at the umbo and beak, but depressed toward the front by a strong, broad, and deep median sinus. Area low,

short, and divided midway by a relatively large triangular delthyrium. Transverse sections of the umbo near the beak show the cross section of a well developed spondylium supported on a medium septum. Dorsal valve about as convex as the ventral on the umbo but the strong, broad median fold makes it more strongly convex anteriorly. Cross sections at the umbo show a spondylium and supporting septum very much like that in the ventral valve.

Observations.—This species is taken as the Cambrian type of the genus *Syntrophia*. It has a spondylium in each valve supported by a median septum in the same manner as in the Ordovician type of the genus *S. lateralis*. Its rotund form, deep ventral sinus, and strong dorsal fold serve to distinguish *S. rotundata* from other species of the genus.

Formation and locality.—Upper Cambrian. Limestone on Wolf Creek, Big Horn Mountains, 14 miles west-southwest of Sheridan, Wyoming.

SYNTROPHIA TEXANA, new species.

Camerella sp.? SHUMARD, Am. Jour. Sci., 2d ser., XXXII, 1861, p. 221.

This may be called the plicate species of the group of forms referred to *Syntrophia*. It is intimately connected with the smooth forms by a series of shells that vary from 16 ribs on a valve to 1. In form *S. texana* is much like *S. abnormis*; also in the cross section of its spondylium. They differ in the extravagant development of the plications of *S. abnormis*, a feature characteristic of a large series of specimens.

S. texana occurs in great numbers in one of the upper limestone beds of Packsaddle Mountain.

The average size of the larger shell is, width, 8 mm., length 6 to 7 mm.

It is probable that this is the shell referred to by Doctor Shumard as *Camerella* sp.? He said of it—

There are several specimens of small brachiopod in the Texas State collection from the Potsdam sandstone of Morgan's Creek, Burnet County, which appear to belong to the genus *Camerella* recently created by Mr. E. Billings. Unfortunately, however, they consist merely of detached and imperfect valves, too much weathered for satisfactory determination and description.^a

Formation and locality.—Upper Cambrian. Packsaddle Mountain, Llano County, Texas.

SYNTROPHIA TEXANA LAEVIUSCULUS, new variety.

A variety occurs in Texas with few traces of plication in the sinus; with one, two or three strong plications on the dorsal fold, or none at all; it approaches *S. abnormis* in some of its extreme forms where the

^aThe Primordial Zone of Texas, with descriptions of New Fossils, American Jour. Sci., 2d ser., XXXII, 1861, p. 221.

ribs are large on a prominent mesial fold; in most young shells the sinus and fold are inconspicuous, the convexity is very moderate and the shell smooth; nearly all the characters of the adult are missing.

A group of young shells from Honey Creek shows only the smooth, slightly convex forms with only slight ventral sinus and dorsal fold. One larger shell associated with the young shells has a relatively deep sinus and a trace of a plication.

Formation and locality.—Upper Cambrian. Cold Creek Canyon and Honey Creek, Burnet County, Texas.

Genus POLYTOECHIA Hall and Clarke.

Polytoechia HALL and CLARKE, Pal. N. Y., VIII, 1892, Pt. 1, p. 239, pl. VII A, figs. 26–30.

Original diagnosis.—Shell small, subtriangular in contour. Hinge line straight, about equaling the diameter of the shell. Pedicle [ventral] valve with a high, nearly vertical cardinal area marked with oblique striations parallel to the lateral margins. Delthyrium covered by a narrow, convex plate; the presence of a foramen not determined. On the interior the dental lamellæ are widely separated and descend along the umbonal cavity for a short distance vertically, thence bending sharply inward and meeting at a low angle in the median line, thus forming, with the deltidium, a conspicuous subrostral vault. This inner spoon-shaped plate, spondylium, is supported by a stout median septum, and two smaller lateral septa, which meet at the lines of angulation; the former of these extends for the entire length of the plate, while the latter is free from the accessory septa near its anterior edge. The umbonal cavity of the valve is thus divided into five chambers, and in the lateral chambers there is still another septum, lower than the rest and not extending to the spondylium. The brachial [dorsal] valve is shallow and depressed-convex, with a narrow cardinal area. The delthyrium is very broad, with a partially developed covering, the dental sockets are widely separated, the crural plates narrow and nearly parallel to the hinge line. The cardinal process is simple, linear and quite prominent, and at its union with the crural plates is a subtriangular thickening which is supported by a low median septum. Surface covered with fine, elevated radiating striae, without evidence of median fold and sinus.

Type.—*Hemipronites apicalis*, Whitfield.

Observations.—This genus is known only in the Lower Ordovician strata of Vermont and Montana. The type species is described as having a convex deltidium covering the delthyrium of the ventral valve; this character and the additional septa supporting the spondylium and cruralium are the distinguishing characters between it and *Syntrophia*. There is still less difference from *Clitambonites*, as in the latter the convex deltidium is present. It is quite probable that representatives of the genus will be found in the Upper Cambrian formations when they are searched more thoroughly.

POLYTOECHIA ? MONTANENSIS, new species.

This shell was placed with *Camerella calcifera* until sections were made showing the numerous septa supporting the spondylium and cruralium. In general form it is close to *Syntrophia rotundata*, differing in the numerous supporting septa of the spondylium which

divide the umbonal cavity into fine chambers. The material available for study does not show the area in very good preservation; a delthyrium exists in the area of the ventral valve which is all that can be said.

This species appears to be a direct descendant of the smooth, convex forms of *Syntrophia* like *S. rotundata*.

Formation and locality.—Lower Ordovician. Limestone east side of Gallatin River above Gallatin City, Montana.

SWANTONIA, new genus.

The description of the type species includes that of the genus, as there is only one other species now referred to the genus and that is very imperfectly known.

Type.—*Camarella antiqua*, Billings.

SWANTONIA ANTIQUATA, Billings.

Camarella antiquata BILLINGS, Pal. Foss., I, 1861, p. 10, fig. 13.

Camarella antiquata BILLINGS, Geol. Vermont, II, 1861, p. 949, fig. 353.

Camarella antiquata BILLINGS, Geol. Canada, 1863, p. 284, fig. 290.

Camarella antiquata WALCOTT, Bull. U. S. Geol. Survey, No. 30, 1886, p. 122, pl. VII, fig. 8.

Camarella antiquata WALCOTT, Tenth Ann. Rept. U. S. Geol. Survey, 1891, p. 613, pl. LXXII, fig. 3.

Camarella? antiquata HALL and CLARKE, Pal. New York, VIII, 1893, Pt. 2, p. 220.

Protorhynchia? antiquata SCHUCHERT, Bull. U. S. Geol. Survey, 1897, No. 87, p. 334.

Ventral valve ovate, moderately convex; apex pointed and incurved over the area nearly to the plane of the margins of the valve; surface marked by from 8 to 12 or more rounded ribs that extend back well toward the apex; a slight flattening of the median portion suggests that a shallow median sinus may be found on old shells. The shell illustrated has a length and width of 11 mm.

A cast of the interior of a ventral valve shows no traces of muscle scars or vascular markings; two strong teeth are indicated, also a narrow, strong, concave shelf or area; the area shelf is free from contact with the bottom of the valve, a recess or chamber existing beneath it.

Observations.—The area or shelf may be considered a short, free spondylium, corresponding to the short spondylium of *Camarella volborthi* as illustrated by Hall and Clarke.^a It differs from the latter in the absence of a supporting median septum.

Swantonina is closely related to *Camarella*, but it differs in the absence of a supporting median septum beneath the spondylium of the ventral valve. No specimens of the dorsal valve have been observed.

^aPal. New York, VIII, Pt. 2, pl. LXII, fig. 18.

Formation and locality.—Lower Cambrian, in sandy shales with *Olenellus thompsoni*, *Kutorgina cingulata*, and *Iphidea labradorica*. One and a half to 2 miles east of Swanton, Vermont.

SWANTONIA WEEKSI, new species.

This shell has the general form of *Swantonina antiquata*, but the ribs are finer, more numerous, and crossed by fine, sharp concentric striae. Only the exterior of the ventral valve appears to be represented in the collection made by Mr. F. B. Weeks.

Formation and locality.—Lower Cambrian. In an argillaceous shale with fragments of *Olenellus*, *Kutorgina spinosa*, etc. Three miles north of Volcaldi Spring, or 4 miles northwest of Drinkwater mine, Silver Peak District, Nevada.

OBOLELLA ASIATICA, new species.

General form broad, oval, with the ventral valve showing a tendency to become bluntly acuminate. Valves gently convex. Surface of shell marked by concentric, raised lines of growth that form the front edge of narrow lamellæ of varying width; the raised lines are highest on their front side, which gives an imbricated appearance to the surface; fine concentric striae occur on the interspaces between the raised lines. Shell strong, calcareous.

The specimens occur in a compact, bluish-gray oolitic limestone. None of them show the area or interior of the valves. The reference to *Obolella* is based on the general form and calcareous shell. The shells vary in size from 3 mm. to 5 mm.

Obolella asiatica may be compared with young shells of *O. crassa*. Its broadly elliptical form and slight convexity distinguish it from other species of the genus.

It may be that if material is found showing the interior of the valves the generic reference will be changed; but with the data now available the reference is to *Obolella*.

The geological horizon is in some doubt as the specimens were found in a block of river drift limestone. The associated fragments of trilobites are too indefinite for determination. *Obolella* is a Lower Cambrian genus as far as known, and other blocks of river drift limestone at the same locality contained fragments of *Olenellus*, so the reference of the species is made to the Lower Cambrian.

Formation and locality.—Lower Cambrian. River drift on the Lan Ho River, 1 mile south of Chen Ping Hsien, Southern Shensi, China.

Collection of Bailey Willis and Eliot T. Blackwelder, Carnegie Institution of Washington, expedition to China.

ACROTRETA ATTENUATA Meek.

- Acrotreta attenuata* MEEK, Sixth Ann. Rep. U. S. Geol. Sur. Terr., 1873, p. 463.
Acrotreta gemma WALCOTT, Monog. U. S. Geol. Sur. VIII, 1884, p. 17; Bull.
U. S. Geol. Sur. No. 30, 1886, p. 98; Monog. U. S. Geol. Sur., XXXII, 1899.
Pt. 2, p. 449.

The species is characterized by its elevated ventral valve and narrow, incurved false area. Some of the forms of *A. idahoensis alta* look like *A. attenuata*, but the false area is different. *A. kutorgai* has a somewhat similar false area and elevation, but it is a less robust shell and the apex of the ventral valve is nearer the posterior margin. The reference to *A. gemma* is explained under the description of the genus. A shell with a distinctly marked false pedicle groove in the ventral valve, occurs in the *Bathyriscus wheeleri* zone of the Middle Cambrian of Utah that shows fine interiors of both valves. The interiors of the ventral valve are much like those of *A. kutorgai*.

Formation and locality.—Middle Cambrian. Flathead terrane. Valley of East Gallatin River near Hillsdale. North of Gallatin River. Base of limestone series resting on Flathead shales, Beaver Creek, 6 miles north of York, Big Belt Mountains, Montana. On divide at head of Sheep Creek near the north end of Teton range, Wyoming. South slopes of Marjum Pass, west of divide, House range, Utah. Above *Bathyriscus wheeleri* zone $2\frac{1}{2}$ miles east of Antelope Springs, House range, Utah.

Upper Cambrian. In the Hamburg shale, a little south of the Hamburg mine, Eureka district, Nevada.

ACROTRETA ATTENUATA, variety?

A shell with a distinctly marked false area is separated as a variety of *A. attenuata*. It is associated with the type specimens in the east Gallatin Valley.

ACROTRETA BISECTA Matthew.

- Acrotreta baileyi* MATTHEW? Trans. Roy. Soc. Canada, IX, 1892, p. 43, pl. XII, fig. 7d.
Acrotreta bisecta MATTHEW, Bull. Nat. Hist. Soc. New Brunswick, IV, 1901, p. 275, pl. v, figs. 5a-g; IV, 1902, pl. v, p. 394; pl. XVI, figs. 2, 2a-g.
Acrotreta sipo MATTHEW, Bull. Nat. Hist. Soc. New Brunswick, IV, 1902, Pt. 5, p. 406, pl. XVIII, figs. 1 and 2.
Acrotreta sipo MATTHEW, Geol. Sur. Canada, Rep. Cambrian rocks, Cape Breton, 1903, p. 185, pl. XVIII, figs. 1 and 2.
Acrotreta bisecta MATTHEW, Geol. Sur. Canada, Rep. Cambrian rocks, Cape Breton, 1903, p. 186, pl. XI, figs. 5a-g.

Nearly all the ventral valves of this species are more or less compressed in the shale, thus decreasing the true elevation. Mr. Matthew illustrates a pointed, high ventral valve, but does not state whether the figure is diagrammatic. Some of the casts in the shale indicate a

sharply conical ventral valve. When the apex is broken off the cast of a median apical callosity is seen, with the base of the cast of a medium-sized foraminal tube. The cardinal scars are small and nearly concealed by the cast of the strong main vascular sinuses. There is considerable range of variation in the size and length of the median ridge of the dorsal valve. One specimen shows a strong median ridge, cardinal and central scars, and deeply excavated false deltidium. Surface marked by fine concentric striae and lines of growth and very fine undulating striae, that give the concentric striae a fretted appearance when examined by a strong lens.

The most nearly related species appears to be *A. sabrinæ* of the Shingleton shales. Dr. G. F. Matthew has described a shell as *Acrotreta sipo* that occurs with the *Asaphellus* fauna. I am unable to detect any specific differences between it and *A. bisecta* from the same area.

Formation and locality.—Upper Cambrian. Barrachois Glen, 4 miles south of Little Bras D'Or Lake, Cape Breton. Mr. Matthew's types came from McLeod Brook, Cape Breton, Nova Scotia, and he also identifies it from division C, 3c., at Navy Island, St. John Harbor, New Brunswick. Mr. S. Ward Loper found many specimens at several horizons in the shales on both sides of the Barrachois River near the Boisdale road and for some distance north, also on the east branch of the Barrachois River, Cape Breton, Nova Scotia. On the west bank it is associated with *Asaphellus homphrayi* var. as identified by Dr. G. F. Matthew.

ACROTRETA? CANCELLATA, new species.

The only specimen of this species in the collection has more the form of *Iphidea* than *Acrotreta*. In its overhanging false area it suggests *Acrothyra*. Whatever the genus may be to which it belongs, its cancellated surface serves to distinguish it from forms to which it might otherwise be compared. This surface is formed by very fine, raised, concentric lines or ridges of growth, crossed by sharp radiating lines which are seen only between the concentric lines.

Formation and locality.—Ordovician Pogonip limestone, Round Top Mountain, Eureka District, Nevada.

ACROTRETA EGGEGRUNDENSIS Wiman.

Acrotreta eggegrundensis WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1; Studien Nordbaltische Silurgebiet, p. 55, pl. II, figs. 23-29.

This species is of a characteristic Middle Cambrian type of *Acrotreta*, represented in America by *A. idahoensis* and *A. kutorgai*. The surface is marked by unusually strong lines and ridges of growth and the false area is well defined. It is quite distinct from other species of the genus in European formations.

Formation and locality.—Middle Cambrian. Coarse grained, somewhat friable, glauconitic sandstone. Drift boulder No. 3 on Eggegrund Island, North Baltic region, Sweden.

For note on the geological horizon see description of *O. (Westonia) bottnica*.

ACROTRETA EMMONSI, new species.

Only the interiors of the two valves are known of this species. One of them shows the distinct character of the vascular markings and muscle scars. The only shell with which it can be compared is the dorsal valve of *Acrotreta idahoensis*. At first sight I was inclined to refer this shell to *Obolella*, but its corneous test, cardinal muscle scars, and absence of area of the *Obolella* type, prevented. Fragments of *Olenellus* occur in the layer of limestone from which the specimens were obtained.

The specific name is given in memory of Dr. Ebenezer Emmons, who studied and wrote of the Bald Mountain section.

Formation and locality.—Lower Cambrian. Limestone interbedded in shales on upper part of the west slope of Bald Mountain, township of Greenwich, Washington County, New York.

ACROTRETA LIANI, new species.

Shell small, about 1.5 mm. in diameter; outline of aperture sub-circular, the posterior side being slightly transverse. Ventral valve conical with the apex a little in advance of the posterior margin; false area indefinite, except for a rather strong, flat furrow that extends from the apex to the margin; the elevation of the valve is about two-thirds its diameter at its aperture. Dorsal valve slightly convex, apex marginal. Surface of shell marked by fine, concentric striae and lines of growth that on the dorsal valve tend to form low ridges toward the outer margins.

Observations.—This species is the representative of the American *Acrotreta idahoensis sulcata*. It has the same type of false area, and the ventral valve is of average height. The specific name is given in recognition of Lian, Mr. Willis's faithful Chinese interpreter.

Formation and locality.—Middle Cambrian. Chang Hsia limestone in upper oolitic portion, Chang Hsia, Shantung, China.

Collections of Mr. Eliot Blackwelder, Carnegie Institution of Washington, expedition to China.

ACROTRETA NEBOENSIS, new species.

This is one of the *Acrotreta idahoensis* forms of the genus. The ventral valve is moderately elevated, the apex projecting slightly over the nearly vertical false area. The latter is marked midway by a very narrow false pedicle furrow.

The transverse dorsal valve has a strong median depression, which starts on the umbo and widens out rapidly toward the front. The surface of the shell is marked by concentric ridges and lines of growth and very fine concentric striae.

This species differs from other described forms in the strong median depression of the dorsal valve.

Formation and locality.—Middle Cambrian. Limestone above quartzite, Mount Nebo Canyon, 3 miles southeast of Mona, Utah.

ACROTRETA NOX, new species.

This minute shell, 1 mm. in length, is characterized by its low ventral valve, nipple-like apex, and apparently smooth surface.

Formation and locality.—Upper Cambrian. Argillaceous shales in St. Croix sandstone, 8 miles east of Baraboo, Wisconsin.

ACROTRETA PACIFICA, new species.

Ventral valve a high cone, with the apex a little in advance of the posterior margin; base circular, with the exception of a slight flattening on the posterior side; apex acute and pointing upward; false area only a slight flattening of the shell from the apex to the margin. The largest ventral valve has a diameter and height of about 1.5 mm. Surface marked by fine concentric striae that continue without noticeable deflection across the false area.

Observations.—Only two specimens of the ventral valve of this species occur in the collection. One of these has a slightly transverse, broadly oval base, and a more definite false area. The species is closely related to *Acrotreta idahoensis alta*, except that the ventral valve is not quite as elevated.

Formation and locality.—Middle Cambrian. Chang Hsia limestone at Yen Chuang and $3\frac{1}{2}$ miles southwest of Yen Chuang; 3 miles southwest of Yen Chuang in limestone nodules at base of green shale phase of the Chang Hsia oolitic formation; Shantung, China.

Collections of Mr. Eliot Blackwelder, Carnegie Institution of Washington, expedition to China.

ACROTRETA SHANTUNGENSIS, new species.

Shell small. Ventral valve a low cone with the apex a little forward of the posterior margin, which is slightly flattened; apex minute, directed backward and projecting slightly over the faintly defined false area. The cast of the interior shows that the apical callosity was rather large and the main vascular sinuses well defined on each side of it; the cardinal scars are small and not prominent.

Dorsal valve slightly convex; apex marginal; surface marked by a rather broad shallow median depression that begins on the umbo and gradually widens toward the front margin. The interior of the dorsal

valve has a strong median ridge extending from the posterior margin two-thirds the distance toward the front. A small elevated cardinal scar occurs on each side of the median ridge a little in advance of the posterior margin. Main vascular sinuses rather strong; they start beneath the apex and extend forward a short distance from the outer lateral margin of the shell. Surface marked by fine concentric striae and lines of growth.

Observations.—This shell in size and general form is closely related to *Acrotreta microscopica* of the Middle Cambrian fauna of the United States. It occurs quite abundantly in a chocolate-colored limestone associated with *Obolus* (*Lingulella*) *chinensis*.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Yen Chuang and $2\frac{1}{2}$ miles south of Yen Chuang, Shantung, China.

A shell apparently identical with *A. shantungensis* was collected from a fine-grained bluish-black limestone river drift block 1 mile south of Chen Ping Hsien, on the Lan Ho River.

Collections of Mr. Bailey Willis and Mr. Eliot Blackwelder, Carnegie Institution of Washington, expedition to China.

ACROTRETA SPINOSA, new species.

The general form of this shell is much like that of *Acrotreta idahoensis*. It differs in having a straighter posterior margin. The main character of the species is the spinose outer surface. The surface is marked by fine concentric lines of growth at irregular intervals, with numerous, very fine, thread-like striae between. On some shells radiating, more or less irregular, fine, rounded ridges occur that are formed by the elevated elongate spine bases. When these elongate bases are irregularly arranged, the radiating ridges are not present. Owing to their minute size the spinules are rarely seen.

Formation and locality.—Upper Cambrian, Hamburgh shale. Hamburgh Ridge; east side of Sierra Canyon opposite Pinnacle Peak and also opposite the Jackson Mine, Eureka District, Nevada.

ACROTRETA UPLANDENSIS Wiman.

Acrotreta uplandensis WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903. Pt. 1; Studien Nordbaltische Silurgebiet, p. 54, pl. II. figs. 15-18.

This species recalls at once *A. idahoensis sulcata*. It differs from it in having a broader false area. The surface is marked by fine thread-like striae that cross the false area and false pedicle groove.

Formation and locality.—Middle ? Cambrian. Gray bituminous sandstone in drift boulder No. 2 on Biludden Island. Also in glauconitic sandstone, boulder No. 1, at Höganäs Commune of Börstil, Sweden.

ACROTRETA UPLANDICA LIMONENSIS Wiman.

Acrotreta uplandica limonensis WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1; Studien Nordbaltische Silurgebiet, p. 54, pl. II, figs. 19-22.

Doctor Wiman states that this species is quite like *A. uplandica*, but lower, as the height is only one-third of the diameter. It is so close in all other respects that I do not think that more than a varietal value should be given to the differences mentioned.

Formation and locality.—Middle ? Cambrian. Bluish calcaneous sandstone. Drift boulder, Limon Island, Gefle Bay, Sweden.

ACROTHYRA MINOR, new species.

This species differs from others referred to the genus by its broad form and very strong vascular sinuses. The elevated callus between the sinuses is high and oval in outline, somewhat like that of *Acrotreta inflata*. It may be that this species belongs to a different genus, but with the material available for study it is referred to *Acrothyra* on account of its low, overhanging false area and elongate visceral area.

Formation and locality.—Middle Cambrian. Two miles southeast of Malad City, Idaho.

ACROTHELE (?) MINUTA, new species.

Shell minute, 1.5 mm. in diameter, subcircular in outline, gently convex, with a slight median depression from the umbo to the anterior margin; back of the umbo there is a sharp median depression between minute ridges, on each of which there are two points or nipples. Surface marked by fine concentric striae. Substance of shell apparently phosphatic.

This interesting little species is represented by a single specimen. The generic reference is somewhat doubtful.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Two and one-half miles southwest of Yen Chuang, Shantung, China.

Collection of Eliot Blackwelder, Carnegie Institution of Washington, expedition to China.

ACROTHELE RARUS, new species.

Of this shell only the interiors of the valves are known. Shells of average size are about 3.5 mm. in diameter. The outline of the valve is subcircular, the transverse diameter being slightly more than the length of the valve. The interior of the ventral valve shows that the valve was moderately convex with a perforated apex about one-half a millimeter from the posterior margin. A short, broad median ridge extends for a short distance in front of the foraminal opening and short, narrow ridges extend obliquely forward from each side of the opening. What may be lateral muscle scars occur close to the postero-lateral margins. In the dorsal valve a strong median ridge extends

from the posterior margin to the center of the valve; this ridge is angular at the summit and broadest toward its anterior end. A vascular sinus starts on each side of the base of the median ridge and extends obliquely forward.

The dark interior surface of the valves is marked by concentric lines that give a somewhat laminated appearance to the surface. From the manner in which the shell adheres to the limestone matrix, it is probable that its outer surface is roughened by raised lines, somewhat as on *Acrothele subsidua*.

The data for comparison of this species with described species from America and Europe are too limited to be of value. A comparison with *Acrothele (mobergia) granulata*, Redlich, of the Salt Range, India, shows a strong similarity in the interiors of the dorsal valves; but I do not think it is probable that the two forms are specifically identical, as the interiors of the valves of several species of *Acrothele* appear very much alike.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Three miles south of Kao Chia Pu, Shantung, China.

Collected by Mr. Eliot Blackwelder, of the Carnegie Institution of Washington, expedition to China.

IPHIDELLA, new genus.

Iphidea BILLINGS, Can. Nat., new ser., VI, 1872, p. 477, fig. 13, and of AUTHORS.—
Not *Iphidea* BAYLEY, 1865.

For synonymy and description of *Iphidea*=*Iphidella*, see Proc. U. S. Nat. Mus., XIX, 1897, p. 707.

IPHIDELLA MAJOR, new species.

Ventral valve subconical, with the apex slightly in front of the posterior margin. A minute beak appears to incurve over the pseudodeltidium. Cardinal slope rather abruptly rounded so as to indicate a rather narrow area. Pseudodeltidium broad, convex, with its lower margin arched so as to leave a space between it and the hinge line of the shell. Dorsal valve slightly convex, with a narrow area and broad, apparently open delthyrium.

Surface, as far as can be determined from the badly preserved material, marked by very fine concentric striae.

The material representing this species is more or less compressed and distorted in the argillaceous shales in which it occurs. In general form it is not unlike that of *I. labradorica*, but it differs in its nearly smooth surface and the position of the apex. From *I. superba* it differs in its much greater size, although resembling it in the narrow and perfectly defined area of the ventral valve, and the large, broad, convex pseudodeltidium.

Formation and locality.—Lower Cambrian. Argillaceous shales, 4 miles south of Helena, Shelby County, Alabama.

IPHIDELLA NISUS, new species.

Ventral valve rather low, with the apex overhanging the posterior margin. Surface marked by very fine lines of growth with still finer bands of striae between them. About 10 very fine, radiating ridges extend from near the apex to the front and lateral margins.

This little shell is represented by a single specimen of the ventral valve from the conglomerate limestones near Bic. The associated fauna included fragments of *Olenellus*.

I was at first inclined to refer this shell to *I. sculptilis* or *I. peali*; but the overhanging apex and strongly marked surface, and the fact that there is an interval of 2,000 miles between the species, led me to separate them. Stratigraphically the two latter species occur in the Middle Cambrian and *nisus* in the Lower Cambrian. I think the two forms should not be included in one species.

Formation and locality.—Lower Cambrian. In a boulder of the limestone, 2 miles west of Bic Station, Province of Quebec, Canada.

IPHIDELLA, species undetermined.

Iphidea, sp. undet. WALCOTT, Mong. U. S. Geol. Sur., XXXII, 1899, p. 449, pl. LX, fig. 6.

Dorsal valve, semicircular, slightly convex. Hinge line somewhat shorter than the width of the shell below; nearly straight, the rostral angle about 180°. Beak small, not elevated. Surface ornamentation consists of extremely fine radiating and undulating concentric striae that can be seen in detail only with a strong magnifying glass. Shell substance horny.

This form is associated with *I. sculptilis* and, judging from external characters, is closely related to it. The surface ornamentation is of the same character, and in the absence of the ventral valve it is difficult to distinguish any specific characters on which to base a new species, although the shell is much larger than that of typical *I. sculptilis*.

Formation and locality.—Middle Cambrian. Flathead terrane (lowest fossiliferous bed); Crowfoot section, Gallatin range, Yellowstone National Park, Wyoming.

IPHIDELLA LABRADORICA ORIENTALIS, new variety.

Only one dorsal valve of this shell occurs in the collection. Its general form and surface characters are very much like those of *Iphidella labradorica swantonensis*. The varietal name is given more on account of the fact that this shell occurs in China and the variety *swantonensis* on the eastern side of the North American continent than from any marked differences between the shells from the two localities. It may be that with a good series of shells from China differences would be found that are not to be determined with only the single shell for comparison.

Formation and locality.—Middle Cambrian. Chang Hsia oolitic limestone, Yen Chuang, Shantung, China.

Collections of Mr. Eliot Blackwelder, Carnegie Institution of Washington, Expedition to China.

IPHIDELLA LABRADORICA UTAHENSIS, new variety.

The general form of this variety is much like that of *Ipheidella labradorica*. It differs from it in the fine thread-like concentric striae of the outer surface, in this respect approaching *I. alabamaensis* and *I. superba*.

Formation and locality.—Middle Cambrian. Concretionary limestone above quartzitic sandstone, Ophir City, Oquirrh Range, Utah.

IPHIDELLA PANNULA MALADENSIS, new variety.

IPHIDELLA PANNULA OPHIRENSIS, new variety.

In collections from the Middle Cambrian limestones of northern Utah and southern Idaho, material has been selected for illustration which represents variety of form and surface markings of *Ipheidella pannula* that might be given specific names were it not for the intermediate phases which occur at the same locality with the varieties. The specimens from near Malad City, Idaho, show a wide variation in outline and surface. Another series from near Ophir City, Utah, illustrate the entire evolution of the "pannula" type of surface, from the concentric striae to the fine network of oblique, raised lines dividing the surface into minute, diamond-shaped depressions. In some examples the ridges are so sharp and clear that the surface has a honeycomb-like appearance.

For convenience of reference the species might be subdivided into three varieties:

Variety A.—Surface with pore-like pits, formed by obliquely crossing, elevated lines.

Variety B.—Surface with elevated, sharp ridges that give it an irregular honeycomb-like appearance.

Variety C.—Surface formed by raised, concentric lines and ridges that inosculate and become more and more irregular until a typical surface represented by variety A is developed.

The first variety, A, is typical of the species. For the second variety the name *maladensis* is proposed, and for the third variety the term *ophirensis*.

Genus KUTORGINA Billings.

Kutorgina BILLINGS, Pamphlet; and Geol. Vermont, II, 1861, p. 948, footnote, figs. 347-349; Geol. Surv. Canada, Pal. Foss., I, 1865, p. 9, figs. 8-10.—DAVIDSON, Brit. Foss. Brach., III, 1871, p. 342.—DALL, Bull. U. S. Nat. Museum, VIII, 1877, p. 40.—WALCOTT, Bull. U. S. Geol. Survey, No. 30, 1886, p. 101.—BEECHER, Am. Jour. Sci., 3d ser., XLI, 1891, p. 345.—HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, pp. 90, 166, 183; Eleventh Ann. Rept. New York State Geologist, 1894, p. 247, pl. iv, figs. 11-13.

Mr. Billings proposed the genus *Kutorgina* in a footnote accompanying the description of the type species *K. cingulata*. He says:

Since the above was written I have examined many casts of the interior of this species, and am inclined to the opinion that it is generically distinct from *Obolella chromatica*. From the very considerable elevation of the beak the dorsal valve must have an area and probably a foramen. In one specimen there are two large oval impressions faintly impressed, but still distinctly visible. There is no trace of the lateral scars; and the form, notwithstanding the characters of the surface, conveys the idea of an *Orthisina*. Should, upon further examination, my suspicions turn out to be well founded, I shall call the genus *Kutorgina*, after the celebrated European naturalist, Kutorga.

From our present information of the genus the following diagnosis is prepared:

Shells inequivalve, transverse or elongated. Ventral valve convex, with apex marginal or incurved over the pseudoarea. Cardinal area rudimentary, without delthyrium or well-defined pseudodeltidium. The latter usually extends one-half the distance from the apex to the plane of the posterior margins of the valve. Interior of the ventral valve with well-defined main vascular sinuses, with a visceral area between the sinuses. Dorsal valve flat or slightly convex, rising to a small, elevated umbo; apex marginal and usually pointing upward; cardinal area short, rudimentary, and without well-defined pseudodeltidium. Interior of ventral valve with median septum between the central and posterior lateral muscle scars.

Observations.—The short cardinal areas of the valves leave a broad open space between them for the passage of the pedicle. The areas are more than the reflected posterior margins of the valves, as they have transverse lines of growth and a suggestion of a pseudodeltidium. These features are more rudimentary than in *Iphidella*. *Kutorgina* includes the larger calcareous shells, and *Iphidella* the somewhat more specialized, smaller, corneous shells. The exterior form of the valves of *Kutorgina* suggest *Nisusia festinata*, with which the type species, *K. cingulata*, is associated in Vermont and at Bic Harbor.

The following species are now referred to *Kutorgina*:

K. cingulata Billings, *K. perugata* Walcott, *K. sardiniaensis* Walcott, and *K. sp. undet.* All the species are from the lower Cambrian horizon, with the possible exception of *K. sardiniaensis*.

Of species heretofore referred to the genus the following disposition is made:

K. labradorica Billings = *Iphidella*.

K. labradorica swantonensis = *Iphidella*.

K. latourensis Matthew = *Protorthis*.

K. minutissima Hall and Whitfield = *Iphidella sculptilis*.

K. pannula White = *Iphidella*.

K. prospectensis Walcott = *Iphidella*.

- K. sculptilis* Meek = *Iphidella*.
K. stissingensis Dwight = *Iphidella*.
K. whitfieldi Walcott = *Billingsella*.

KUTORGINA CINGULATA Billings.

- Obolella* (*Kutorgina*) *cingulata* BILLINGS, Geol. Vermont, II, 1861, p. 948, figs. 347-349; Pal. Foss., I, p. 8, figs. 8-10.
Obolella cingulata BILLINGS, Geol. Canada, 1863, p. 284, fig. 287.
Obolella? phillipsi HOLL, Quart. Jour. Geol. Soc., XXI, 1864, pp. 101, 102, figs. 10a, b.
Kutorgina cingulata DAVIDSON, Geol. Mag., V, 1868, p. 312, pl. xvi, fig. 10; Brit. Sil. Brachiopoda, 1871, p. 342, pl. L, fig. 25.
Kutorgina cingulata WALCOTT, Bull. U. S. Geol. Survey, 1886, p. 102, pl. ix, fig. 1.
Kutorgina cingulata BEECHER, Amer. Jour. Sci., 3d ser., XLI, 1891, p. 345.
Kutorgina cingulata WALCOTT, Tenth Ann. Rept. U. S. Geol. Survey, 1891, p. 609, pl. LXIX, fig. 1.
Kutorgina cingulata HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, p. 92, figs. 47-49; pl. IV, figs. 10-17.
Kutorgina cingulata VON TOLL, Mem. de l'Acad. Imp. des Sci. de St. Petersburg, VIII ser., 1899, I, Beit. zur Kenntniss des Siberischen Cambrium, p. 26, pl. I, fig. 28.

General form transversely or longitudinally oval; biconvex, with the ventral much more convex than the dorsal valve. Surface marked by concentric lines and ridges of growth and the edges by imbricating lamellae of growth. Shell substance calcareous and fibrous. The shell is formed of a thin, dark, compact outer layer and a thick, fibrous, calcareous inner layer. It is possible that the thin outer layer is chitinous, but it does not appear to be so. The L'Anse au Loup and Bic Harbor shells average about 15 mm. long by 17 mm. in width. At the Swanton locality, in Vermont, ventral valves occur 24 mm. in height and with a width of 30 mm., and one large dorsal valve is 20 mm. in length with a width of 30 mm.

Ventral valve in young shells moderately convex, becoming more and more convex with increase in size and age. In young shells the slope from the front margin to the apex is nearly straight, and the apex terminates at the posterior edge of the valve above the more or less elevated pseudodeltidium. In old shells the curvature from the front to the apex is nearly a semicircle, and the apex terminates in a pointed beak overhanging the pseudodeltidium. A mesial sinus of varying strength occurs on many shells, and in others it is entirely absent. The pseudo area is concave on the outer parts. Toward the center it becomes slightly flattened or convex and thus forms a very rudimentary pseudodeltidium. It extends beneath the apex at an angle of about 45° to the plane of the margins of the valve. The central portion of the pseudo area extends about one-half the distance from the apex to the plane of the valve and forms a gentle arch.

A partially exfoliated shell shows four dark lines radiating forward

from the umbo and two near the sides that may have something to do with the muscle scars or vascular sinuses. I thought so in 1886,^a but am not sufficiently confident of it now to state it as a settled conclusion. Fine punctæ occur on the inner layer of the shell; also numerous radiating lines about one-half a millimeter apart.

Dorsal valve gently convex in young shells. With increase in size the umbo becomes more elevated and the apex points upward or terminates at the union of the pseudo area and the upward slope of the shell on the umbo. In some shells there is a tendency for the valve to become slightly concave in the space between the margins and the elevated umbo. The pseudo area of the valve is narrow and with little character; on some shells it slopes beneath the apex, and on others it slopes backward, forming a low angle with the surface of the valve. The interior of the dorsal valve shows a median septum, with two central scars, and the anterior lateral scars. Numerous small vascular canals radiate from central concave area toward the flattened anterior and lateral half of the valve. A cast of the interior shows two vascular canals radiating forward from near the apex. Radiating lines occur on the interior of the same character as those of the ventral valve.

Observations.—Since writing on this species in 1886 I have collected specimens showing the character of the pseudo areas of the valves, and also obtained further information relative to the interior of the dorsal valve. The rudimentary or pseudo areas are less advanced in development than those of *Iphidella*, and the muscle scars of the dorsal valve are much like those of *Obolella* and *Obofus*.

The specimens from Bic Harbor and east of Swanton, Vermont, are better than those from the type locality at L'Anse au Loup. Many of the Vermont shells are larger and more fully developed, but specimens of the same size as those from L'Anse au Loup and Bic Harbor are identical in the characters available for comparison.

Formation and locality.—Lower Cambrian. L'Anse au Loup limestone with *Olenellus thompsoni* at L'Anse au Loup, on the north shore of the straits of Belle Isle, Labrador. In bowlders of limestone containing fragments of *Olenellus*, in Cambrian conglomerate, at East Point, Bic Harbor, Province of Quebec, Canada. The species is abundant in lenticular masses of limestone intercalated in argillaceous and arenaceous shales carrying *Olenellus thompsoni* on the Bullard farm, about two miles east of Swanton, Vermont.

Dr. Eduard von Toll^b identifies and illustrates as *Kutorgina cingulata* Billings a dorsal valve that occurs with other forms that may be referred to the Lower Cambrian fauna of the Cambrian of Siberia.

Locality.—Near the Tschurskaja Station, on the Lena.

^a Bull. U. S. Geol. Survey, No. 30, p. 103.

^b Beiträge zu Kenntniss des Sibirischen Cambrium, I. Mém. de l'Acad. Imp. des Sci. de St. Pétersbourg, VIII sér., 1899, pp. 26-27.

KUTORGINA PERUGATA, new species.

General form ovate, biconvex. Surface marked by concentric lines of growth and more or less strong concentric corrugations; the outer surface is ornamented by a fine network of oblique, depressed lines, that leave minute rhomboidal elevations between them that look like fine papillæ under a moderately strong magnifier, and the cast of the surface has much the same appearance in a transverse light. Shell substance calcareous.

A large ventral valve has a length of 14 mm.; width, 16 mm. A dorsal valve 11 mm. in length has a width of 14 mm.

The ventral valve is strongly convex in adult shells, with the highest point near the umbo or at the apex. The apex terminates at or overhangs a rudimentary pseudo area that slopes beneath the shell at an angle of 45° to 60° to the plane of the margins of the valve. The pseudo area is concave and about half the length of the space between the apex and the plane of the valve. Casts of the interior show well-defined main vascular sinuses, with the outline of the visceral area between them.

The dorsal valve is transverse, nearly flat in some examples, and slightly convex in others. The surface slopes gradually from the margins to near the umbo, where the slope increases and extends to the upward-pointing apex. A rudimentary pseudo area slopes backward from the apex. In some examples the pseudo area appears to be little more than a bending over of the posterior margins of the shell; in others it has the outline of a slightly convex pseudodeltidium.

Observations.—This species, in its reticulate surface ornamentation, recalls *Lophidella pannula* and *Mickwitzia monilifera*. In form the young shells are not unlike *Kutorgina cingulata*. A large, imperfect ventral valve, 24 mm. by 24 mm., of this genus, was collected by Mr. J. E. Clayton from the Cambrian limestone of the Silver Peak district. It may belong to *K. perugata*, and it is so referred for the present. From the shales of the Olenellus zone in Silver Canyon, White Mountain range, a series of compressed specimens were collected. Some of these show a concave pseudo area on the ventral valve, also strong main vascular sinuses. Some of the shells from the shales north of Red Mountain have lost all traces of surface characters, only a faint, smooth impression remaining.

Formation and locality.—Lower Cambrian. Calcareous shales beneath Archaeocyathus limestone, 3 miles north of Valcadi Spring or 4 miles northwest of Drinkwater Mine; summit on road 10 miles southwest of town of Silver Peak; also on divide between Clayton and Fish Creek valleys, north of Red Mountain, Silver Peak Range; Silver Peak District, Esmeralda County, Nevada. About 1,000 feet above quartzite, Silver Canyon, White Mountain Range, Nevada.

KUTORGINA SARDINIAENSIS, new species.

Kutorgina cingulata BORNEMANN, Nova Acta der Ksl. Leop-Carol. Deutsch. Acad. Naturf., LVI, 1891, No. 3, p. 440, pl. XIX, figs. 22, 23.

Lingula rouaulti BORNEMANN, Nova Acta der Ksl. Leop-Carol. Deutsch. Acad. Naturf., LVI, 1891, No. 3, p. 439, pl. XIX, fig. 21.

Transversely oval, more or less arched, with straight margin which is a little shorter than the greatest breadth of the shell. Surface shows strong concentric lines of growth.

Found quite commonly in the slates with *Olenopsis* and *Metudorides* near Canalgrande, solitary also in sandstone with *Archæocyathus* on Punta Pintau. The specimens in slate are always pressed very flat, and are imperfect; in the sandstone are found impressions of the outer surface.

Here belongs perhaps also the shell designated above as *Lingula rouaulti* (?).

The specimens of this species are all more or less flattened in the argillaceous shale. It appears to be congeneric with *Kutorgina cingulata*, but not specifically identical with it.

Formation and locality.—Middle? Cambrian shales near Canalgrande, and in sandstone on Punta Pintau, Island of Sardinia.

KUTORGINA, species undetermined.

Ventral valve transverse, moderately convex; length 6 mm., width 8 mm.; pseudo area short and sloping beneath the apex at an angle of about 45°.

A single cast from a coarse sandstone is all that is known of this species. It may be a young shell of *K. cingulata*, but the means of comparison do not justify such a reference.

Formation and locality.—Lower Cambrian sandstone of Sollings Mountain, 2 miles east of Natural Bridge, Virginia.

RUSTELLA, new genus

All that is known of this genus is the type species, *Rustella edsoni*. It appears to be the most primitive form of brachiopod known.

The generic name is given in memory of William P. Rust, of Trenton Falls, New York, whose collections from the Lower Cambrian strata of Georgia, Vermont, were most extensive and the material the finest obtained there.

RUSTELLA EDSONI, new species.

General form, subcircular, biconvex. Ventral valve moderately convex, with the apex at the posterior margin immediately above a low arch in the posterior margin. Surface smooth except for concentric growth lines and low ridges that in some shells are quite prominent. A shallow, broad, rudimentary pedicle groove occurs beneath the apex

and on a slightly flattened space adjoining the posterior margin. Dorsal valve about as convex as the ventral and with the apex marginal. The interior of the valve shows two rounded depressions beneath the umbo with a slight, narrow groove between them; a little in advance the outlines of the central muscle scars occur; originally strong but faintly indicated radiating lines occur toward the front.

Observations.—This shell was identified as the dorsal valve of *Kutorgina cingulata* by Mr. Billings^a and myself.^b They were considered as distorted, flattened shells. Better material shows them to represent one of the simplest forms of brachiopod known; with the exception of the rudimentary pedicle furrow and the area there is nothing more than the gaping valve, a form near to Dr. Charles E. Beecher's ideal *Paterina*.

The specific name is given in recognition of the excellent work Mr. George Edson, of St. Albans, Vermont, is doing in collecting the Lower Paleozoic fossils of his region.

Formation and locality.—Swanton shales, just above Parker's quarry, Georgia, associated with *Olenellus thompsoni*, and also two miles east of Swanton, Vermont.

Genus DICELLOMUS Hall.

Dicellomus HALL, Twenty-third Ann. Rep. N. Y. State Cab. Nat. Hist., p. 246.

Dicellomus HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, p. 72.

Dicellomus WALCOTT, Mon. U. S. Geol. Survey, XXXII, 1899, Pt. 2, p. 446.

Shell small; general form ovate to subsemicircular, biconvex, with apices marginal. Surface of outer shell finely punctate in all species where it is preserved uninjured. Interior or middle lamellæ marked by radiating striæ and minute punctæ; inner surface finely punctate. The shell is thick in all the species now known, and is built up of a thin, outer, scabrous layer, numerous inner layers or lamellæ, and a thin inner layer. Shell substance apparently calcareo-corneous.

The interior of the ventral valve shows a short area with a median pedicle groove; an elongate visceral area; well-marked main vascular sinuses; large, composite scars where the posterior muscles, i. e., transmedian and anterior laterals, were attached; and a short shelf or embryo spondylium that extended into the valve from each side of the pedicle groove. This plate corresponds to the dental plate in the articulate brachiopods, and it has a thickness at the antero-lateral margin that suggests a short tooth.

The interior of the dorsal valve has a well-defined but very narrow area in one species, *D. politus*, that is hollowed out so as to form a shallow groove on each side, apparently for the reception of the short tooth of the ventral valve. No good posterior margins of the valve

^aPal. Fos., I, p. 9.

^bTenth Ann. Rept. U. S. Geol. Survey, p. 609, pl. LXIX, figs. 1, 1a-h.

could be found of the other species of the genus. The composite scar is large, and in one shell it is subdivided into three small scars that were the points of attachment of the transmedian, outside, and middle laterals. The central and anterior lateral scars are arranged as in *Obolus*; the centrals are large and located on the sides of the visceral area; the anterior laterals are small and located at the arterial end of the visceral cavity.

Observations.—When referring to *Dicellomus*, in 1899, I said:^a

When proposing that the genus *Dicellomus*^b include *Obolella polita*, Professor Hall stated that the grooving or emargination of the apices of both valves and the thickening of the edges of the shell on each side below the apex, together with the form and character of the muscular impressions, would separate the species from *Obolella*. Again in 1892 Messrs. Hall and Clarke^c gave a fuller description of *Dicellomus politus*, but owing to the poor character of the material they did not feel confident that it should be recognized as generically distinct from *Obolella chromatica*. Material now in the collections of the Geological Survey clearly shows that Professor Hall's provisional conclusion was correct, and that *Dicellomus politus* is generically distinct from *Obolella chromatica*.

The presence of the large, composite, cardinal muscle scars in each valve suggests that a search be made for a foraminal opening, as in *Obolella*, *Linnarssonella*, and *Aerotreta*. No trace has been found externally, and the interior of the ventral valve does not show evidence of it. *Dicellomus* appears to include characteristics of *Obolus* and *Obolella*, and on the presence of the incipient dental plates, teeth, and dental grooves an articulate shell is suggested. In *Meekina prima* a step further is taken in the development of the spondylium and in the approach toward articulating brachiopods.

The stratigraphic range of *Dicellomus* is from the Middle Cambrian to the latter part of the Upper Cambrian. Its geographic distribution includes the Appalachian area in Tennessee and Alabama, the Mississippi basin from Wisconsin and Minnesota on the north to Oklahoma on the south and South Dakota, Montana, and Utah on the west. The Arizona locality appears to be an extension to the southwest of the upper Mississippi Valley species, *D. politus*. The only form from Europe is suggested by the unidentified shell from the *Paradoxides forchhameri* zone of Anduarum, Sweden.

The species now referred to the genus are:

Dicellomus appalachia, Middle Cambrian.

D. parvus, Middle Cambrian.

D. pectenoides, Middle Cambrian.

D. politus, Middle Cambrian.

D. species undetermined, Middle Cambrian.

D. nanus, Upper Cambrian.

^a Mon. U. S. Geol. Survey, XXXII, Pt. 2, 1899, p. 446.

^b Twenty-third Ann. Rept. New York State Cab. Nat. Hist., p. 246.

^c Pal. New York, VIII, Pt. 1, p. 72.

DICELLOMUS APPALACHIA, new species.

This shell has been identified with *D. politus* in the preliminary studies of the genus *Dicellomus*. I find that while it has the same type of shell structure and general form, it differs in being less elongate proportionally, and in the details of the form and positions of the muscle scars and vascular markings of the interior of the valve; it differs in the latter respect from *D. nanus*. The outer thin layer has a dull, slightly roughened surface that is minutely punctate. When the outer layer is exfoliated the surface of the layer beneath is highly polished and marked by exceedingly fine radiating striae and concentric striae and lines of growth. The interior of the dorsal valve shows the larger central muscle scars with the minute antero-lateral scars almost in contact with them. A composite scar shows the separate points of attachment of the transmedian, outside, and middle lateral scars. The variation in the length of the visceral cavity of the dorsal valve is very great.

This species occurs in great abundance in both limestones and shales. It is the representative of the widely distributed *D. politus* of the interior of the continent.

Formation and locality.—Middle Cambrian. Limestones beneath the upper shale of the Cambrian section at many localities in Jefferson and Hawkins counties; limestone layers in Conasauga shale, 2 miles south of Coal Creek, Anderson County; in shale on road from Rogersville to Dodson Ford; limestone at Bull Run, Copper Ridge, 11 miles northwest of Knoxville, southwest of Maynardsville, and 5 miles southeast of Greenville, Tennessee.

Coosa shale, Cowan Creek and Cedar Bluff, Cherokee County, Murphrees Valley, and Blountsville Valley, Alabama.

DICELLOMUS NANUS Meek and Hayden.

Obolella nana MEEK and HAYDEN, Proc. Acad. Nat. Sci. Philadelphia, 2d ser., V, 1861, p. 435.—BILLINGS, Pal. Foss., I, 1862, p. 67.—HAYDEN, Am. Jour. Sci., 2d ser., XXXIII, 1863, p. 73.—MEEK and HAYDEN, Pal. Upper Missouri, Pt. 1, 1864, p. 4, pl. I, figs. 3a-d.—WHITFIELD, U. S. Geog. and Geol. Surv. Rocky Mountain Region, 1880, p. 340, pl. II, figs. 14-17.—HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, p. 69.

Dicellomus nanus WALCOTT, Mon. U. S. Geol. Survey, XXXII, 1899, p. 447, pl. LX, figs 3, 3a-d.

The principal characters of this species are the same as *Dicellomus politus*. The two forms differ exteriorly in *D. nanus* being more convex on the umbones and less elongate. The interior of the ventral valve shows a less elongate visceral area, a relatively larger composite muscle scar. The interior of the dorsal valve of *D. nanus* has a much larger composite muscle scar, a broader visceral area with the central muscle scar farther from the median line.

One of the types of *D. nanus* is the interior of a ventral valve, on which there is a subtriangular depression that appears to have been the path of advance of the area, on each side of the median space, in which the central muscle, middle, and outside lateral muscles were attached. Another shell from the Big Horn Mountains shows something of the same character.

The area of the ventral valve is short, and divided midway by a shallow pedicle furrow; area of dorsal valve unknown.

The exterior of the shell appears to be smooth and slightly polished, except for fine concentric striae and lines of growth and what appear to be scattered punctae.

The average size of the adult shells is from 3 mm. to 4 mm., the length and width usually being nearly the same.

The exact horizon of the type specimens is unknown. They occur in a somewhat friable, purplish sandstone, unlike any beds of the Middle Cambrian Deadwood sandstone that I met with. The specimens from the limestones of the Big Horn Mountains, etc., appear to belong to the Upper Cambrian terrane.

Formation and locality.—Upper Cambrian. Shaly sandstone, Black Hills, North Dakota. Limestone above shales, about 10 miles south-southeast of Bald Mountain, Big Horn Mountains; Gallatin limestone, Crowfoot section, Gallatin Range, Yellowstone National Park, Wyoming. Limestone of the Little Rocky Mountains, west side of Dry Creek, below Pass Creek, Gallatin Valley.

Two specimens of a shell apparently identical with *D. nanus* were broken from a diamond drill core, taken from a fine sandstone 20 feet above the La Motte sandstone, St. Francois County, Missouri.

DICELLOMUS PARVUS, new species.

General form ovate, with the ventral valve subacuminate and dorsal valve broad oval to subcircular. Valves moderately convex. Surface of outer shell dark and polished; it is marked, when not abraded, by fine, clearly defined, concentric striae and occasional lines of growth. The largest ventral valve has a length of 2.5 mm. and a width of 2 mm. The shell is strong but not thick. Shell substance apparently calcareo-corneous.

Ventral valve uniformly convex, except that the slopes toward the cardinal margins are more abrupt than elsewhere; apex appears to be marginal. The interior of the valve shows a short, low, median ridge in the center of the visceral cavity; on each side, and a little in front of the end of the median ridge are the trapezoidal areas for the attachment of muscle scars; rather small, composite cardinal muscle scars occur close to the cardinal margins.

Dorsal valve somewhat less convex than the ventral; apex marginal. The interior of the valve shows well defined composite cardinal muscle

scars, a narrow median septum, and faintly impressed main vascular sinus that curves outward and forward at about one-third the distance from the outer margin to the median septum; the central muscle scars are small and situated back of the center of the valve on each side of a low median swelling on which the median septum occurs; the position of the anterior lateral muscle scars is indicated at the end of the median septum a little in advance of the center of the valve.

Observations.—This minute shell has the generic characters of *Dicel-lomus politus*, but it differs specifically in minute size and the positions of the muscle scars in the dorsal valve.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Two and one-half miles southwest of Yen Chuang, Shantung, China.

Also from a river drift block one mile south of Chen Ping Hsien, on the Lan Ho River, southern Shensi.

Collections of Bailey Willis and Eliot T. Blackwelder, Carnegie Institution Expedition to China.

DICELLOMUS PECTENOIDES Whitfield.

Obolus pectenoides WHITFIELD, Ludlow's Rept. Reconnaissance Black Hills of Dakota, 1875, p. 103, figs. 1, 3.

Obolus? pectenoides WHITFIELD, Geol. and Geog. Surv. Rocky Mountain region, Powell, 1880, p. 328, pl. II, figs. 18, 19.

Obolella pectenoides SCHUCHERT, Bull. U. S. Geol. Survey, No. 87, 1897, p. 275.

This is the largest shell of the several species of the genus. A ventral valve 9 mm. long has a width of 11 mm. All that is known of the structure of the shell indicates that it was like *D. politus*. This species differs from all the other species by the anterior position of the central muscle scars of the dorsal valve, and its larger size.

Formation and locality.—Middle Cambrian. Deadwood sandstone, Castle County, on west side of the Black Hills; also at Deadwood, in the cliffs on the east side of the valley, South Dakota.

DICELLOMUS POLITUS Hall.

Obolus appolinus OWEN (not Eichwald), Geol. Surv. Wisconsin, Iowa, and Minnesota, 1852, pl. I B, figs. 9, 11, 15, 20.

Lingula? polita HALL, Ann. Rept. Geol. Surv. Wisconsin, 1861, p. 24; Geol. Rept. Wisconsin, I, 1862, pp. 21, 435.

Obolella? polita HALL, Sixteenth Ann. Rept. New York State Cab. Nat. Hist., 1863, p. 133, pl. VI, figs. 17-21; Trans. Albany Institute, V, 1867, p. 112.

Lingulepis prima MEEK and HAYDEN, Smithsonian Contrb. to Knowl., XIV, 1864, No. 172, p. 3, pl. I, fig. 2.

Dicel-lomus polita HALL, Twenty-third Ann. Rept. New York State Cab. Nat. Hist., 1873, p. 246.

Obolella polita WHITFIELD, Geol. and Geog. Surv. Rocky Mountain Region, 1880, p. 339, pl. II, figs. 12, 13.

Obolella polita WALCOTT, Bull. U. S. Geol. Survey No. 30, 1886, p. 111.

Obolella polita HALL and CLARKE, Pal. New York, VIII, 1893, Pt. 1, pp. 72, 73, pl. II, figs. 37-41.

Dicellomus politus WALCOTT, Mon. U. S. Geol. Survey, XXXII, 1899, Pt. 2, p. 446, pl. LX, figs. 4, 4a.

General form ovate, with the ventral valve subacuminate; biconvex, the ventral valve usually more convex than the dorsal. Surface smooth as the specimens usually occur, but a few examples show that there is a thin outer layer covered with fine papillæ and punctæ that appear to be placed on very fine, more or less inosculating ridges. Concentric lines of growth of varying strength show on the outer surface, also on the various inner layers or lamellæ. When the outer layer is exfoliated or worn off by attrition of the sand, the surface of the inner layer is marked by radiating striae and concentric lines of growth that are a marked feature of the species. The radiating striae may be uniform in size, or with from 4 to 6 very fine striae between two stronger elevated striae. Inner surface smooth to the eye, but a strong lens shows that it is finely punctate, with exceedingly fine, irregular, raised lines all over the surface. The intermediate layer is more coarsely and irregularly punctate.

The shell is thick and is built up of a thin, scabrous, outer layer, a middle layer made up of several highly polished lamellæ, and a thin inner layer. The numerous inner lamellæ are oblique to the outer surface over much of the shell, and thus give it thickness. Shell substance calcareo-corneous. The usual size of the Wisconsin shells is about 6 mm. long, width 5 mm., for ventral valve, and same width and length for dorsal valve. Specimens from the Black Hills average a trifle larger than those from Wisconsin.

Ventral valve with a uniform convexity over the central portions, from which the surface slopes gently to the margins. Apex nearly, if not quite, marginal. Casts of the interior indicate a short cardinal area that extends out on the cardinal margins of the shell, and that appears to merge into the margins. On each side of the pedicle furrow a thin plate or shelf extended into the valve on the plane of the margins of the shell. Some of the casts indicate that these plates had a projecting boss or tooth that articulated in a rude manner with the depressions on the posterior, flattened, inner margin of the dorsal valve. If this interpretation is correct, the teeth and plates correspond to the teeth and dental plates of the articulate brachiopods, and the plates mark the beginning of a spondylium. The posterior muscles, transmedian and anterior laterals were undoubtedly attached within the area of the composite scar. The visceral area and posterior portions of the main vascular sinuses are well outlined, but no muscle scars or details of the vascular system have been preserved in the material studied.

Dorsal valve most convex back of the center. Apex marginal. The

interior of the valve shows shallow depressions in the flattened posterior margin that suggest dental cavities for the reception of the dental projections of the ventral valve. The composite muscle scar probably formed the point of attachment of the posterior muscles, transmedian, outside, and middle laterals. The central muscle scars are shown a little back of the center of the valve, where a low median ridge bifurcates. In some shells a sharp median septum is shown; also narrow main vascular sinuses.

Observations.—The specimens of this shell from Wisconsin, Minnesota, and North Dakota occur in fine-grained, more or less friable sandstone; those from Montana in a compact limestone in the Gallatin Valley and a siliceous shale at Helena. The reference of the specimens from Helena is rather doubtful, as the shells are compressed and distorted.

The beds in which the specimens are found at Taylors Falls, Minnesota, are said to be Upper Cambrian. If this is correct *D. politus* ranges from the Middle to the Upper Cambrian. Shells agreeing with *D. politus* in all points available for comparison occur in the basal, probably Middle Cambrian, sandstone beneath the great limestone series of Arizona. The material is abundant and preserved very much in the same condition as that from the Deadwood sandstone of the Black Hills of South Dakota.

In the sandstones at the base of the Middle Cambrian Reagan formation a few shells were found that appear to be identical with *D. politus*. They have the elongate form of that species, which is unknown in any other species of the genus.

In the collections made by the fortieth parallel survey there are specimens so closely resembling *D. politus* that they are identified as such, although the dorsal valve is rather transverse.

Dicellonius politus differs from *D. nanus* and *D. pectenoides* in being more elongate; also in the details of the interior markings of the valves. From *D. appalachia* it differs in interior markings and, as specimens average, in being more elongate.

Formation and locality.—Middle Cambrian. St. Croix sandstone, middle beds of the sandstone, at Eau Claire, Wisconsin. Deadwood sandstone, 9 miles west of Custer City; head of Red Water Canyon and several other localities in the Deadwood sandstone of the Black Hills, South Dakota. Gallatin limestone, near Gallatin, and also in Silurian shales with *Obolus* (*Lingulella*) *helena* and *O. (Westoria) ella*, on the southern slope of Mount Helena at Helena, Montana. Basal sandstone. Ash Creek, Pinal County, Arizona. Basal sandstone of the Reagan formation, Wichita Mountains, 11 miles northwest of Fort Sill in the SW. $\frac{1}{4}$ sec. 17, T. 4 N., R. 12 W., Oklahoma Territory.

Upper (?) Cambrian. Upper beds of St. Croix sandstone at Taylors Falls, Minnesota.

DICELLOMUS, species undetermined.

A single specimen of a ventral valve very much like that of *Dicellomus appalachia* occurs with material from the *Paradoxides forchhameri* zone at Andrarum. A series of specimens would probably prove that it is the representative of an undescribed species.

Formation and locality.—Middle Cambrian. Andrarum, Sweden.

CURTICIA, new genus.

The description of the type species, *Curticia elegantula*, includes all that is known of this genus.

The generic name is given in recognition of the excellent work of Dr. Cooper Curtice, of Moravia, New York, both as a field collector and laboratory assistant for several years.

CURTICIA ELEGANTULA, new species.

General form, subcircular, biconvex. Surface of exterior of shell marked by fine concentric, slightly undulating striae, and lines and varices of growth. When the thin, exterior layer is exfoliated, the inner layers are ornamented by numerous fine, radiating lines, very much as in *Dicellomus* and *Obolus*, also more or less imbricating concentric lines. The inner surface shows radiating and concentric lines without the visceral area. Shell substance corneous and probably calcareous. The shell is built up of a thin, outer surface layer and several inner layers or lamellae, slightly oblique to the outer surface on the umbo and central parts of the valves. The lamellae are more oblique and numerous toward the front and sides, and thus thicken the shell over those parts. The average ventral valve has a length of 5 mm., width 6 mm.; dorsal valve, 5 mm. by 5 mm.

Ventral valve strongly convex, most elevated at the umbo, and arching over to a minute, slightly incurved apex; area rudimentary, with a high, triangular, open delthyrium occupying most of it. A cast of the interior of the valve shows that a narrow elevated ridge occurs just in advance of the apex.

Dorsal valve evenly convex, apex marginal. The interior shows a median ridge and septum, with small rounded depressions beneath the umbo on each side of the median ridge and a little in advance of the apex. Ventral muscle scars small and clearly defined. Anterior lateral scars small, and situated in advance of the central scars close to the median ridge and at its anterior extremity. Main vascular sinuses broad and slightly defined.

Observations.—This shell was labeled *Dicellomus politus*. In external form it resembles it, but the open delthyrium of the ventral valve and the absence of area on dorsal valve distinguish it. It appears to be a form intermediate in development between *Rustella* and *Dicel-*

lonius. It occurs in large numbers and is a very striking object, with its dark, smooth shell in the buff-gray sandstone.

Formation and locality.—Upper Cambrian. St. Croix sandstone, Taylors Falls, Minnesota.

QUEBECIA, new genus.

The description of the species includes that of the genus as there is only one species now known.

Type.—*Obolella circe* Billings.

QUEBECIA CIRCE Billings.

Obolella circe BILLINGS, Canadian Nat., n. ser., VI, 1872, p. 219; Am. Jour. Sci., 3d ser., III, 1872, p. 357.—WALCOTT, Bull. U. S. Geol. Survey No. 30, 1886, p. 118, pl. x, fig. 3a; Tenth Ann. Rept. U. S. Geol. Survey, 1891, p. 611, pl. LXXI, fig. 3a.

General form broad ovate, with front and sides uniformly rounded; planoconvex. Surface marked by fine concentric striae of growth. A ventral valve 3.5 mm. in length has a width of 4.5 mm. A dorsal valve 4.5 mm. in length has the same width; a larger dorsal valve, 11 mm. in length, has a width of 10.5 mm. Shell rather thick, and composed of calcite in its present condition.

The ventral valve has an elevated umbo terminating in a sharp, upward pointing apex that may be perforate; from the umbo the surface, in young shells, slopes so rapidly that the central and outer portions of the shell are nearly flat, but in older shells moderately convex; area short and divided midway by a relatively broad delthyrium that is nearly covered by a convex deltidium; the inner surface is marked by fine, elevated, rather widely separated, radiating striae and very fine punctae; a pair of very broad main vascular sinuses arch forward from a point beneath the umbo and inclose a small, slightly elevated visceral area; a strong cardinal tubercle occurs on each side of the pseudo area, which was probably the point of attachment of the posterior muscle, i. e., transmedian and anterior laterals.

Dorsal valve gently convex in young shells, becoming strongly convex in old shells; no traces of an area have been observed—if present it must have been short and very low, as the beak is nearly at the plane of the margins of the shell; casts of the interior show that the valve was thickened beneath the umbo by a ridge that separated what may be called the umbonal cavity from the main cavity of the valve. On the cast of an old shell a rounded, narrow, longitudinal, median ridge divides the umbonal cavity; on each side of the cavity and beyond it there is the strongly marked path of advance of the transmedian muscle scars; in front of the transverse ridge two strong ridges that extend toward the center of the valve occupy the position of the main vascular trunks; in one specimen a narrow groove extends from the central muscle scar along the inside margin of the ridge.

The muscle scars now known are the transmedian and central; the former are situated close to the margin of the valve, and the space assigned them may also include the posterior laterals; the central scars are well indicated in several specimens, but no trace has been found of the antero-laterals. The cardinal tubercle includes the space that was occupied by the several points of attachment of the posterior muscles, i. e., transmedian, outside, and middle laterals; the cast of the tubercle is an elongate depression just inside the margin of the shell.

Observations.—By incorrect interpretation both Mr. Billings and myself identified the dorsal valve of the species as the ventral, and I followed him in illustrating a dorsal valve of *Obolella crassa* as the dorsal valve of *O. circe*. When studying some material representing the species in the collections of the United States National Museum I noticed the edge of a shell that, on working it free from the matrix, proved to be a ventral valve; two dorsal valves occur on the same bit of rock. Subsequently Dr. J. F. Whiteaves sent me a tablet from the collections of the Geological Survey of Canada, on which six specimens were labeled *Obolella circe*. No. 1 is a cast of the interior of the dorsal valve of *Obolella crassa*, and No. 2 the exterior of same. Nos. 3 and 6 are ventral valves of *Quebecia circe*, and Nos. 4 and 5 dorsal valves.

With the ventral valve identified, it appears that the shell is not an *Obolella* but is the type of an undescribed genus, in which the ventral valve is elevated at the apex, and with strong cardinal tubercles for the attachment of the posterior muscle scars, very much as in *Acrotreta*. This feature, and the presence of what appears to be the base of the cast of a foraminal tube, suggest that the ventral valve was perforate. *Quebecia* appears to be on the line of evolution from *Obolella* to the calcareous, perforate, inarticulate shells represented by *Yorkia*. *Obolella*, *Quebecia*, and *Yorkia* are all strong, calcareous, perforate shells of the older Cambrian fauna, and are evidently closely related.

Formation and locality.—Lower Cambrian. Limestone boulders in conglomerate at Trois Pistoles, on the St. Lawrence River, below Quebec, Canada.

Genus ELKANIA Ford.

Billingsia FORD (not de Koninck, 1876), Amer. Jour. Sci., 3d ser., XXXI, 1886, p. 466.

Elkania FORD, Amer. Jour. Sci., 3d ser., XXXII, 1886, p. 325.

Elkania HALL and CLARKE, Pal. New York, VIII, 1892, Pt. 1, pp. 75, 165; Eleventh Ann. Rep. New York State Geologist, 1894, p. 241.

General form ovate, biconvex; shell substance corneous and made up of several thin layers or lamellæ that increase in number toward the front and lateral margins. Surface marked by fine concentric striæ of growth. Apex of both ventral and dorsal valves marginal. The interior of the ventral valve has a thickened posterior section which has a central pedicle furrow, and two flexure lines running obliquely

forward and outward from the apex, a little inside of the grooves of the main vascular trunks; this structure is apparently the result of the union of the area with the bottom of the shell, so as to bring, as the shell grew, the path of advance of the pedicle groove, main vascular sinuses, and lateral muscle scars all on one surface instead of on the area and the shell beneath it, as in *Obolus*.

The muscle scars are arranged as in *Obolus*. The transmedian and anterior laterals occur well out toward the margin, and the space inclosing the central scars, middle and outside laterals, is in the central area, on the front of the slope of the thickened posterior portion of the valve; the points of attachment of the individual muscles can not be distinguished. In the dorsal valve the central and anterior lateral scars are clearly shown in several specimens. The transmedian and outside laterals are situated just outside the main vascular sinus. Our knowledge of the vascular markings is limited to the main vascular sinuses, except in one ventral valve where the inner branches have been preserved. In both valves the main trunk rises near the apex and its path is outlined across the reversed area.

The preceding description differs materially from that of Messrs. Ford and Hall and Clarke. I find the muscle scars as described above, and am compelled to consider them as indicating the same muscles as in *Obolus*. That the genus is an advance on *Obolus* in the evolution of the inarticulate brachiopods, I quite agree with Hall and Clarke; also that it is a stage in the transition from *Obolus* to *Trimerella* and its allies. The stage, however, is not far along, as nothing is seen of the platform in advance of the area, and the area is merged into the body of the shell. *Elkania* is an *Obolus* with the cardinal areas within the plane of the margins of the valves. In the type species, *E. desiderata*, the area of the ventral valve is entirely within the valve, while that of the dorsal valve has been nearly obliterated in the process of change from an open backward-facing area to an inclosed forward-facing area. A comparison of the interiors of *Obolus* (*L.*) *cælatus* and *Obolus apollinis* with those of *Elkania desiderata* and *Elkania bellula* illustrates that little change is necessary to convert the exterior cardinal areas of *Obolus* into the inclosed reversed areas of *Elkania*.

As the beaks of *Elkania* are marginal, the pedicle passed out though an opening made by the gaping of the valves.

The four known species of the genus are the type species, *Elkania desiderata*, *E. ida*, *E. ambigua*, in which the shell is very thick, and *E. bellula*, a minute shell in which the form and tendency is towards *Lingulella* rather than the thick oval forms of *Obolus*.

Lingulasma Ulrich, has an inclosed cardinal area, and is a more advanced stage than *Elkania* in the transition from *Obolus* and its subgenera to the true Trimerelloid forms.^a

^aSee Pal. New York, VIII, Pt. 1, pp. 24-28, 30-33.

Authors have referred frequently to the resemblances between species of *Obolella* and *Elkania desiderata*. These do not appear to exist except in a superficial manner. *Obolella* is a stage in the evolution toward the Siphonotretidae, while *Elkania* is toward the Trimerellidae.

ELKANIA BELLULA, new species.

General form elongate oval; biconvex; beaks marginal. Surface marked by fine concentric striae of growth that occasionally form varices and small ridges near the umbo; the inner layers or lamellae have radiating striae in addition to concentric striae.

The shell is relatively thin and small. It rarely exceeds 2.5 mm. in length and a little less in width; the dorsal valve is a somewhat shorter than the ventral.

Ventral valve subacuminate, moderately convex; the interior shows a reversed cardinal area attached to the bottom of the valve and below the plane of the margins of the valve; the pedicle groove is strong; the line of demarcation between the cardinal area and the bottom of the valve is indefinite, as the margin of the area and the body of the shell have been merged into each other; the transmedian and antero-lateral muscle scars are outside the main vascular sinuses and near the margin of the valve; the central scars and middle and outside lateral scars are supposed to have been attached within an area which is largely on the front slope of the thickening of the umbonal portion of the valve.

The dorsal valve has a short reversed area; the antero-lateral muscle scars were probably well advanced toward the front, judging from traces of the length of the visceral cavity.

The vascular markings include the main vascular sinuses in the ventral valve and traces of the visceral area in the dorsal valve.

This pretty little shell is much like a small species of *Lingulella* in its exterior appearance; the interior connects it with *Elkania*. I know of no species closely related to it.

Formation and locality.—Upper Cambrian. Limestone about 3 miles south of Benders Pass, Silver Peak Range, Nevada.

SCHUCHERTINA, new genus.

The description of the type species is that of the genus and species, as but one species is known of the genus.

Type.—*Schuchertina cambria*.

The generic name is given in recognition of the admirable work that Prof. Charles Schuchert has done on the fossil brachiopods.

SCHUCHERTINA CAMBRIA, new species.

Shell subovate, with valves obtusely acuminate; biconvex. Surface marked by concentric lines and striae of growth and fine radiating

striae. The inner and outer surfaces of the shells have very fine punctae, but no traces of punctae penetrating through the shell have been observed.

The largest ventral valve has a length of 22 mm., width 23 mm.; dorsal valve, length 17 mm., width 18 mm. Shell substance calcareous, rather thick on the umbonal region and thin towards the margins.

Ventral valve subacuminate, moderately convex; on some of the larger shells a broad mesial fold and arching of the frontal margin are present; apex terminates at the margin above a triangular opening or delthyrium; area small and within the plane of the margins of the valve; it is attached to the bottom of the valve and divided midway by a very slight pedicle groove; the margins of the delthyrium-like opening sustain an angle of about 45° to the plane of the valve, and the reversed area within is at its center nearly on the plane of the valve; the anterior margins of the area extend upward to meet the margins of the shell, thus forming a reversed arched area. The interior of the valve is marked by radiating, shallow, narrow furrows that vary in number and strength in different shells; just in front of the area on each side of the median line oval depressions occur which correspond in position and shape to the diductor muscle scars of the ventral valve of the Orthidae, and they are so interpreted. Traces of the adductor scars are found on each side of the median line. Dorsal valve obtusely acuminate, about as convex as the ventral valve; apex marginal on the broad, low, median arch of the posterior margin; no traces of an area have been observed. A broad, shallow mesial sinus and projecting front margin occur on adult shells. The position of the anterior and posterior adductor muscle scars is indicated, also the umbonal thickening in which the diductor muscles were probably attached, as there is no trace of a cardinal process. Radiating furrows like those in the ventral valve are strongly marked in adult shells.

Observations.—*Schuchertina cambria* is a shell that, as far as I know, is unique. In its exterior form it suggests a biconvex Orthoid genus, and this likeness is further increased by the flabelliform scars of the ventral valve; the smooth surface and reversed areas suggest *Elkania*, while the interior umbonal portion of the ventral valve points to *Quebecia*. It may be said that *Schuchertina* is a type derived from some early Cambrian form allied to *Quebecia* and that its general aspects affiliate it with the Orthidae.

Formation and locality.—Middle Cambrian limestone. Thirteen miles south of Neihart, 1 mile below divide on road to Woolsey post-office, Montana.

OBOLUS ACADICA, new species.

Only interiors of the dorsal valve of this species occur in the collections made by Mr. S. W. Loper on McNeils Brook in 1900. The

material was provisionally referred to *O. (L) concinnus*, but the broadly rounded subquadrilateral form of the dorsal valve seems to distinguish it from that species and also from *Obolus (Paleobolus) bretonensis*.

The visceral area is narrow, extending a little in advance of the center of the valve. The main vascular trunks are narrow and widely separated. They belong to the submarginal group and are thus quite unlike those of *O. (P.) bretonensis*. The exterior surface and ventral valve are unknown.

Formation and locality.—Upper Cambrian. Etage 3 of Matthew, McNeils Brook, 1½ miles east of Marion Bridge, Cape Breton, Nova Scotia.

OBOLUS ISMENE, new species.

This species is characterized by its elevated umbo, flattened posterolateral margins, and relatively thin shell.

All that is known of the exterior surface indicates that it was nearly smooth, marked only by fine concentric striae of growth. The inner layers of the shell are beautifully marked by fine concentric and radiating striae that give the surface a cancellated appearance. The shell is built up of several layers or lamellae that become more oblique to the outer surface toward the front.

Formation and locality.—Middle Cambrian. Potosi limestone, Flat River, Missouri.

OBOLUS MATINALIS Hall?

Lingulepis matinalis HALL, Sixteenth Annual Report N. Y. State Cab. Nat. Hist., 1863, p. 130, pl. vi, figs. 12, 13.

A form indistinguishable from this species occurs in a gray limestone of Upper Cambrian age. Only the general form of partially exfoliated shells is known.

Formation and locality.—Upper Cambrian. Chao Mi Tien limestone. Two-thirds of a mile west of Tai An Fu, Shantung, China.

Collection of Eliot T. Blackwelder, Carnegie Institution Expedition to China.

OBOLUS MINIMUS, new species.

This is a small shell of the general form of *Obolus shensiensis*. The ventral valve is obtusely acuminate and the dorsal nearly circular; valves gently convex. Surface marked by rather strong concentric lines of growth and numerous very fine concentric striae. The inner layers of shell are shiny black and ornamented with numerous fine, radiating striae and concentric lines. Shell built up of several thin layers or lamellae that form a thin shell over the umbonal region that gradually thickens as the short, oblique lamellae become more numerous toward the front and side margins. The three specimens in the

collection average 3 mm. in transverse diameter; the ventral is a little longer than the dorsal valve.

A partially exfoliated ventral valve shows a well-marked visceral area, extending forward about one-third of the length of the shell; also narrow main vascular sinuses starting near the apex and extending obliquely forward well into the valve, about midway between the median line of the valve and the lateral margins. This neat little shell is distinguished by its nearly circular outline, low convexity, and small size.

Formation and locality.—Middle Cambrian. Chang Hsia limestone, Yen Chuang, Shantung, China.

Collection of Eliot T. Blackwelder, Carnegie Institution Expedition to China.

OBOLUS NUNDINA, new species.

This little shell differs from *O. anceps*, to which it appears to be most nearly related, by its more nearly circular dorsal valve, and its strongly concentrically-ridged surface. Its surface is formed by elevated, rounded, concentric ridges that are somewhat irregular. Very fine concentric striae occur both on the ridges and on the interspaces between.

Formation and locality.—Middle Cambrian. Cold Creek, Llano County, Texas.

OBOLUS OBSCURUS, new species.

This species is represented by one interior of a small dorsal valve which is very distinctive, the exterior of a crushed dorsal valve, and numerous fragments of the shell scattered through the hard, dark gray, shaly sandstone. The large dorsal valve has a length of 9 mm., width 7 mm. The shell is strong and marked on its inner layers by radiating and concentric striae; the outer surface has numerous fine, elevated, slightly irregular concentric striae that, with a strong lens, give it a roughened appearance.

An interior of a dorsal valve shows a well-developed area, the greater portion of which is taken by the broad pedicle groove; a deep umbonal cavity with a narrow median septum and obscure main vascular sinuses on the outer margins of the cavity. Outside the sinuses on the postero-lateral slope, relatively large muscle scars are indicated.

With the data available no satisfactory comparisons can be made with other species. *O. obscurus* is a large strong shell of the general type of *Obolus rheu* of the Middle Cambrian of Wisconsin.

Formation and locality.—Middle Cambrian. Ku San shale. Three and one-half miles southwest of Yen Chuang, Shantung, China.

Collection of Eliot T. Blackwelder, Carnegie Institution Expedition.

OBOLUS SHENSIENSIS, new species.

General form ovate, with the ventral valve broadly subacuminate and dorsal valve obtusely rounded. Valves moderately convex in the specimens embedded in a fine-grained, dark limestone. Surface marked by fine, sharp, concentric striae and traces of irregular, obscurely defined, low, radiating ridges; the interior layers show fine radiating striae and concentric lines. The shell is strong and built up of numerous lamellae oblique to the outer surface. The largest ventral valve has a length of 9 mm., width 7 mm. Nothing is known of the interior of the valves. The form, surface markings, and shell structure are much like those of *Obolus matinalis* and *O. tetonensis*. In outline *O. shensiensis* is more elongate than *O. matinalis* and less so than *O. tetonensis*.

Formation and locality.—Upper Cambrian. Chao Mi Tien limestone. Eight miles south of Ting Hsiang Hsien, and one mile south of Chen Ping Hsien, Shensi, China.

Collections of Bailey Willis and Eliot T. Blackwelder, Carnegie Institution Expedition to China.

OBOLUS TETONENSIS, new species.

The general form, convexity, and appearance of this species is so much like that of *Obolus matinalis* that a general description is unnecessary. It varies from that species in the shorter, more transverse dorsal valve, and the narrower outline of the ventral valve toward the beak.

This species occurs in great abundance in the thin-bedded limestone in the upper portion of the Cambrian section of the Teton Range, Wyoming, in association with *Billingsella pepina* and *Obolus* (*Lingulepsis*) *acuminatus* var. *meeki*. What appears to be the same species occurs nearly 700 feet lower in the section in a thin-bedded sandstone. The dorsal valve from this horizon is broader and more transverse posteriorly than the dorsal valve from the upper horizon.

Formation and locality.—Middle Cambrian, on the divide at the head of Sheep Creek, near north end of the Teton Range, Wyoming. Thin-bedded limestones, Belt Park, 6 miles out from Neihart, Montana. Three miles southeast of Malad City, Idaho, a smaller form, collected by Dr. A. C. Peale in Bostwick Canyon, Bridger Range, Montana, may belong to this species. It occurs in a fine-grained sandstone low down in the Paleozoic section.

Dark gray limestone, Ophir City, Utah.

OBOLOUS TETONENSIS NINUS, new variety.

This variety differs from the parent species and from *O. matinalis* by the more elongate form of the dorsal valve and the more acuminate form of the ventral valve, the cardinal slopes of the latter extending much further forward in the variety *ninus* than in the two species.

The advanced position of the visceral area in the ventral valve may be compared with the visceral area of *Obolus* (*L.*) *crassus*.

Formation and locality. Middle Cambrian. Reagan formation, one-half mile east of Canyon Creek, 15 miles northwest of Fort Sill, Oklahoma Territory; also on west side of Honey Creek, near SE. corner, sec. 35, T. 1 S., R. 1 E. NE. $\frac{1}{4}$ sec. 2, T. 2 S., R. 1 E. Ardmore map, Geological Survey, Indian Territory.

OBOLOUS PHERES, new species.

This is one of the smallest of the *Obolus* species known to me. It recalls at first sight *O. (L.) winona convexus*; but it differs in having a thick, lamellated shell, and in being more rounded on the cardinal angles. The exterior surface is marked by concentric lines of growth. The shell is built up of thin layers or lamellæ, those toward the front and sides being arranged obliquely to the surface, as in all of the thick-shelled species of *Obolus*.

Formation and locality.—Upper Cambrian. Argillaceous shales, interbedded in sandstone at Fox Glen, 8 miles east of Baraboo, Wisconsin.

OBOLOUS (LINGULELLA) CHINENSIS, new species.

General form broadly subovate with the ventral valve broadly sub-acuminate and the dorsal valve oval with the postero-lateral slopes somewhat straightened. There is some variation in the proportions of width and length in different shells. Valves rather strongly convex for so thin a shell, in this respect resembling species of *Dicellogmus*. Surface marked by fine concentric striæ and lines of growth and very fine undulating concentric lines; this outer surface is usually a dull black and adheres to the matrix; when the outer layer is exfoliated the surface is shiny black and marked by numerous radiating striæ in addition to concentric striæ; the inner surface shows a few scattered punctæ in addition to radiating and concentric striæ outside the visceral area. The shell is of medium thickness and formed of a thin outer layer and several inner layers or lamellæ that are slightly oblique to the outer layer; the lamellæ are more numerous and more oblique to the outer layer over the anterior and antero-lateral portions of the shell. The ventral valves average 3 mm. in length, with width varying from 2 mm. to 2.5 mm. The dorsal valve is slightly shorter than the ventral when the two valves have the same width.

The interior of the ventral valve shows that the area is short and divided midway by a narrow pedicle furrow that merges into the visceral area, which extends forward about one-third the length of the valve; on each side of the anterior central portion of the visceral area there are two small trapezoidal areas within which the central scars and the middle and outside lateral muscle scars were attached; the small transmedian and antero-lateral muscle scars are situated close to the main vascular sinus opposite the anterior portion of the central visceral area. A partial cast of the interior of the dorsal valve shows a rather wide visceral area with the antero-lateral scars about the center of the valve and the central scars about one-fourth of the distance back from the center to the posterior margin. Of the impressions left by the vascular system only the main vascular sinuses of the ventral valve have been seen; these are situated about midway between the central visceral area and the margins of the valve.

Observations.—This species occurs abundantly in association with *Acrotreta shantungensis*. It is closely related in form to *O. (Lingulella) prindeli* of the upper Olenellus zone of eastern New York, and belongs with a group of small shells that have a wide vertical and geographical range, as is noted under the description of *O. L. prindeli*. With the data available for comparison it differs from *O. L. prindeli* in its shorter cardinal area and visceral area in the dorsal valve. From *O. (Lingulella) damesi* it differs in being broader in proportion to its length.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Two and one-half miles south of Yen Chuang, on NNE. spur of Hu Lu Shan, China.

Collected by Mr. Eliot T. Blackwelder, of the Carnegie Institution Expedition to China.

OBOLUS (LINGULELLA) DAMESI, new species.

The general descriptions of *O. L. chinensis* and *O. L. primus* apply so closely to this species that it does not appear necessary to do more than call attention to the points in which they differ. From *O. L. chinensis* this species varies in having a more elongate, acuminate ventral valve and ovate dorsal valve; the valves are also less convex. From *O. L. primus* it differs in the more gradual curvature of the sides from the apex to the front margin, in this respect resembling some varieties of *O. L. ferrugineous*. The average size of the ventral valve is about 5 mm. in length by 3.5 mm. in width.

The species is named after Dr. Wilhelm Dames, who first described the Cambrian faunas of China.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. About 3 miles southwest of Yen Chuang, Shan Tung, China.

Collected by Mr. Eliot T. Blackwelder, of the Carnegie Institution Expedition to China.

OBOLUS (LINGULELLA) ISSE, new species.

In form and size this shell recalls *O. (L.) pogonipensis*; it differs from it in the form of the dorsal valve and the character of the outer surface. The shell is rather strong and made up of several thin layers or lamellae. Its outer surface is marked by concentric lines of growth, sometimes grouped in more or less elevated bands, and over all there is a thin encrusting or scabrous layer that has a minutely granular, dull surface, somewhat like that of *O. (Lingulepis) gregua* but very much finer in its granulations or points. The inner layers of the shell are dark, shiny, and marked by concentric lines of growth and radiating striae.

Formation and locality.—Middle Cambrian. Near Cave Spring, Fish Creek Range, Utah.

OBOLUS (LINGULELLA) ORUS, new species.

This is a shell of the *O. (L.) manticulus* form, but differs from it in being more elongate; ventral valve more acuminate and dorsal valve proportionally larger. Its nearest allies in form are among the group of narrow, elongate shells occurring across the continent at Cape Breton. It differs from all of them *O. (L.) collicia*, *O. (L.) flumensis*, *O. (L.) canius*, etc: in having a thick, strong shell and usually more acuminate dorsal valve. The exterior surface bears rather strong concentric lines of growth, and very fine, irregular, undulating, elevated striae that suggest the surface of *O. (Westonia) ella*, when seen in a reflected light with a strong magnifier.

This little shell occurs abundantly, but good interiors have not been found. The main vascular sinuses appear to be submarginal in both valves, and the visceral area of the dorsal valve narrow, extending a little beyond the centre of the valve.

Formation and locality.—Middle Cambrian. Limestones of the Reagan formation, interbedded in the middle part of the Reagan green-sand, 15 miles north of Fort Sill, one-half mile east of Canyon Creek, Wichita Mountains, Oklahoma Territory.

OBOLUS (LINGULELLA) PELIAS, new species.

This shell most nearly resembles *O. (L.) desideratus*. It differs in the squareness of the dorsal valve caused by the slightly curved sides and cardinal slopes. The ventral valve suggests the broader forms of *O. (L.) desideratus*, and the dorsal valve those of *O. (L.) mosia* and *O. (L.) winona* of the St. Croix sandstone.

The outer surface of the shell is marked by clearly defined concentric lines that are slightly irregular, and narrow, fine radiating undulations or costae toward the frontal margins. When unusually well preserved, the surface also shows very fine, irregular concentric

striae between the concentric lines. The inner lamellae of the shell are marked by fine radiating striae and the inner surface by more or less numerous punctæ, very much as in *O. (L.) punctatus*. For its size the shell may be considered as relatively thin.

A single specimen of a ventral valve that is doubtfully referred to this species was collected 3 miles south of Antelope Springs, Utah, in limestone forming a spur of the House Range.

Formation and locality.—Middle Cambrian limestones of Fish Spring Range near north end; also a little south of the middle of the range, Utah.

The exact stratigraphic horizon of the limestones carrying this species is unknown. It is well up in the Middle Cambrian or in the Upper Cambrian.

OBOLUS (LINGULELLA) QUADRILATERALIS, new species.

General form rounded, quadrilateral; moderately convex. Surface marked by concentric lines and ridges of growth, with fine striae between. The surface of the inner layers of the shell is shiny and marked by fine radiating striae in addition to the concentric lines. The shell is rather thin; it is built up of several layers.

This species differs from other described species by its subquadrilateral outline. In this respect it may be compared with *O. (Westonia) chuarensis*, from which it differs in having a thinner shell and different surface markings.

Formation and locality.—Middle Cambrian. Coosa Valley shales, Cedarbluff, Cherokee County, Alabama.

OBOLUS (LINGULELLA) SEPTALIS, new species.

The dorsal valve is all that is known of this little shell. There are two specimens in the collections of the United States National Museum and three in the collection of Mr. Bryan E. Walker, of Toronto, Canada.

The general form of the valves is much like that of *O. (L.) rotundatus*. It is distinguished from the latter and other described species by the strong median ridge and septum of the dorsal valve. The outer surface is marked by concentric striae and lines of growth and very fine irregular concentric striae that give a minutely rough surface.

Formation and locality.—Middle Cambrian. Silicious shales, Mount Stephen, British Columbia.

OBOLUS (LINGULELLA) UPIS, new species.

This is a small, elongate shell of the group to which *O. (L.) orus* belongs. It differs from the latter in being more elongate and in its marked surface characters, and from *O. (L.) collicia*, *O. (L.) flumensis*, *O. (L.) canius*, and allied forms, in having a thick, strong shell and highly characteristic exterior surface.

The shell is thick, the anterior portions being made up of numerous lamellæ oblique to the exterior surface, in this respect resembling some of the species of *Obolus* having thick shells. The exterior surface is marked by concentric lines of growth, with very fine, somewhat irregular striae between them. These show very distinctly on the anterior portion of the shell. Farther back they become very irregular, giving a crenulated appearance to the striae and lines of growth, and the surface looks as though it were formed of thin, imbricating scales or lamellæ.

The surface of *O. (L.) upis* suggests that of *O. (Westonia) euglyphus*, but I have been unable to find traces of the transverse lines characteristic of *Westonia*.

Formation and locality.—Middle Cambrian. One mile west of Cherokee, San Saba County, Texas.

OBOLUS (LINGULELLA) FUCHSI Redlich.

Lingulella fuchsi REDLICH, Pal. Indica, new ser., I, 1899; Cambrian Fauna, Eastern Salt Range, p. 7, pl. 1, figs. 10a-e.

In the collection received from Doctor Noetling I find that there occurs in association with *O. (L.) wanniecki* a small, elongate form that appears to be identical with *L. fuchsi* of Redlich. Doctor Redlich states that his *L. fuchsi* occurs in hard clay above the lower magnesian sandstones which rest on the shales containing *O. (L.) wanniecki*. If my identification of the species is correct, *O. (L.) wanniecki* has a greater vertical range, or there may have been some error in identification and in the labeling of the zone from which the original specimens were obtained. The identification of the species in the material before me is based on the form of the ventral valve, as shown by Doctor Redlich's figure 10c. Dorsal valves differ materially from his illustration; but in another specimen a little pit mentioned by Doctor Noetling is shown, also two ridges that leave a concave furrow in the central portion of the cast of the valve. These are the lines of the main vascular sinuses.

Formation and locality.—Middle Cambrian. Zone of *Hoeferia noetlingi*, in dark argillaceous shales, Khussak, Salt Range, India.

OBOLUS (LINGULELLA) WANNIECKI Redlich.

Lingulella wanniecki REDLICH, Pal. Indica, new ser., I, 1899; Cambrian Fauna, Eastern Salt Range, p. 7, pl. 1, figs. 9a-d.

General form broadly ovate, with the ventral valve obtusely acuminate and the dorsal valve rounded subtriangular; convexity moderate in the specimens embedded in argillaceous shales. There is considerable range of variation in the outline of the valves. The surface of the shell is marked by concentric lines of growth and very fine, closely undulating raised striae that inosculate so as to give the surface a

granulated appearance. This type of surface occurs on *O. (L.) isse* and *O. (L.) upis*. The anterior layers of the shell are marked by radiating and concentric striae, and the interior of the shell has scattered punctae in addition to the radiating and concentric striae. The shell is relatively thick and formed of several layers or lamellae in addition to the very thin, outer, ornamented layer.

The visceral area of the ventral valve is short, and the main vascular sinuses are about half way between the center of the shell and the lateral margins. In the dorsal valve the visceral area is well developed beyond the center of the shell, and the vascular sinuses are farther out proportionally than in the dorsal valve. The central and anterior lateral muscle scars are placed on an elevated central ridge, on each side of a sharp median septum.

Observations.—This very pretty little shell occurs in great numbers in the dark argillaceous shales with *Hoeferia noetlingi* Redlich. Doctor Redlich states that it is the only species of the genus in the collection sent to him. In the collections made by Dr. Fritz Noetling I find associated with *Hoeferia noetlingi*, *O. (L.) wanniecki*, *O. (L.) fuchsi*, "*Mobergia-Acrothele granulata*" Redlich; also specimens of a species of *Hyalolithes* undescribed.

Among the American species of *Lingulella*, *O. (L.) wanniecki* may be compared in form with *O. (L.) zetus* and *O. (L.) oweni*. Its surface is much like that of *O. (L.) upis* and *O. (L.) orus*. It is distinct from all described species when its form and surface are taken into consideration, as there is no species with its subtriangular form that has its granulated surface.

Formation and locality.—Middle Cambrian. Zone of *Hoeferia noetlingi*. Dark argillaceous shales, Khussak, Salt Range, India. The formations containing this fauna are referred to the Middle Cambrian, as there is no evidence that the Cambrian fauna of India above the upper Annelid sandstone, as described by Dr. Fritz Noetling and Doctor Redlich, is older.

OBOLUS (LINGULEPIS) EROS, new species.

Ventral valve elongate with rostral slopes gradually converging so as to form an acuminate beak. Surface marked by fine concentric lines of growth and very fine, somewhat irregular, concentric striae. Rather large scattered punctae occur on the interior surface.

This species is represented by fragments and two broken ventral valves; these indicate a length for the ventral valve of from 7 to 10 mm. It is allied to *O. (Lingulepis) acuminatus weeksi* of the Middle Cambrian fauna of the Teton Mountains of Wyoming.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Three miles southwest of Yen Chang, Shantung, China.

Collected by Mr. Elliot Blackwelder of the Carnegie Institution expedition to China.

OBOLUS (LINGULEPIS) ROWEI, new species.

In outline and convexity the valves of this species are closely related to those of *O. (Lingulepis) acuminatus*. It differs from the latter and other described species by the strong, raised, concentric lines, with very imperfectly defined fine striae between them.

The specific name is given in memory of Mr. R. B. Rowe, assistant geologist, who collected the material representing this species a short time before his death.

Formation and locality.—Middle Cambrian. Reddish-brown sandstone. Resting Springs, Inyo County, California.

OBOLUS (WESTONIA) ALANDENSIS, new species.

Lingula? sp. No. 2. *Lingulella?* sp. Nos. 3 and 5. WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1; Studien Nordbaltische Silurgebiet, p. 52, pl. II, figs. 33, 35, 39.

This species is characterized by its broad form when compared with *O. (Westonia) bottnica*, *O. (Westonia) winani*, and *O. (Westonia) baltica*. Its surface is marked by fine concentric lines of growth, with very fine, thread-like, concentric striae between them. Under a strong, reflected light, almost microscopic, transverse, very irregular lines can be seen that give the surface somewhat the appearance of that of *O. (Westonia) ella*.

Formation and locality.—Middle? Cambrian. Gray, bituminous sandstone in drift boulders on Åland and Biludden shores of Gefle Bay, Sweden.

For reference to geological horizon, see description of *O. (Westonia) bottnica*.

OBOLUS (WESTONIA) BALTICA, new species.

Lingulella? sp. No. 4 and 6. WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1; Studien Nordbaltische Silurgebiet, p. 52, pl. II, figs. 34, 37, 38.

This species is characterized by its elongate form, with the sides of the dorsal valves regularly rounded from the back to the rounded frontal margin. The dorsal valves are also more regularly and strongly convex than in other species occurring in the Cambrian sandstones of Sweden. The outer surface is marked by concentric and radiating striae, crossed obliquely by very fine, irregular transverse striae. The latter are only to be seen with a strong magnifier and favorable light.

Formation and locality.—Middle? Cambrian. Gray, bituminous sandstone. Drift boulders at Biludden, shore of Gefle Bay, and Skälstenarne. Also near Öfverby in the "Gemeinde of Jomala Åland."

OBOLUS (WESTONIA) BLACKWELDERI, new species.

General form elongate, with the width about one-half the length; front margin broadly rounded; sides slightly arched up to the lateral slopes which are quite straight in the ventral valve and curved toward the rounded posterior end of the dorsal valve; the beak of the ventral valve is pointed and marginal. The convexity of the valves is moderate, that of the dorsal apparently being the greater. Surface marked by concentric striæ and lines of growth which are crossed by irregular, fine, imbricating, more or less transverse lines; the transverse lines trend slightly backward toward the sides of the valves. A dorsal valve 8 mm. in length has a width of 5 mm.

Observations.—Nothing is known of the interior of the valves. When the shell is broken from the limestone, the outer surface usually adheres to the matrix. The best exteriors are those of shells on the surface of the layers. Of the known species of *Westonia*, *O. (W.) wimani* and *O. (W.) baltica* are most nearly related to *O. (W.) blackwelderi*. The latter is a larger shell and also less narrow proportionally where the gently arching sides pass into the postero-lateral slopes.

Formation and locality.—Middle Cambrian. Chang Hsia limestone. Two, and two and one-half miles south of Yen Chuang, Shantung, China.

Collected by Mr. Eliot Blackwelder of the Carnegie Institution expedition to China.

OBOLUS (WESTONIA) BOTTNICA Wiman.

Lingula bottnica WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1. Studien Nordbaltische Silurgebiet, p. 51, pl. II, figs. 40-44.

The description of *O. (Westonia) finlandensis* so closely applies to the description of this species that it is only necessary to point out the difference between the two.

The surface of *O. (Westonia) bottnica* has the same concentric and radiating lines, with the irregular transverse lines terminating at right angles to the margins, curving inward and backward in such a manner as to obliquely cross the radiating lines that extend from the umbo forward to the anterior and antero-lateral margins. The central scars of the dorsal valve are much further forward in *O. (Westonia) bottnica*.

Formation and locality.—Middle? Cambrian. Coarse grained, somewhat friable, glauconitic sandstone, drift boulder No. 3 on Eggegrund Island, North Baltic.

Dr. Carl Wiman refers this species to the *Olenellus* sandstone series. The boulder containing it also carried *Aparchites? anderssoni*, *Hipponicharior matthewi*, *Acretreta eggegrundensis*, *Kutorgina?? torellella lævigata*, and fragments referred to *Olenellus*. This fauna is essentially Middle Cambrian in its facies, and unless the fragments referred

to *Olenellus* are indisputably of that genus, I am inclined to refer the bowlder and its contained fossils to the Middle Cambrian. The fact that *O. (Westonia) bottnica* is nearly identical with *O. (Westonia) finlandensis* of the *Paradoxoides tessini* series of Finland, also points to the Middle Cambrian age of the fauna.

OBOLUS (WESTONIA) IPHIS, new species.

This shell differs from all other species of *Westonia* in having a more elongate and acuminate ventral valve, and in the presence of a marked mesial depression on the dorsal valve. The shell is rather thin and made up of several very thin layers or lamellæ. The outer surface is marked by fine radiating striæ, concentric striæ, and lines of growth, and fine more or less undulating, transverse lines that cross both the radiating and concentric lines. The transverse lines appear to be the edges of slightly elevated imbricating lamellæ of the shell.

Formation and locality.—Upper Cambrian and Ordovician. Lower Ordovician Pogonip formation, Hamburg Ridge; also near the Bullwacker Mine, in the Upper Cambrian Eureka District, Nevada.

OBOLUS (WESTONIA) THEMIS, new species.

General form subsemicircular, with the ventral valve subacuminate and the dorsal valve broadly ovate in outline. Valves rather strongly convex. Surface of the shell marked by strong concentric lines of growth with finer intermediate striæ; in addition there are very fine, irregular, raised, more or less transverse striæ that inosculate, forming a minutely papillose or granular surface much like that of *O. (W.) ella*. It often occurs that the outer surface has been removed by attrition in the sand, so that the shell has a smooth, polished surface. Owing to the condition of preservation, the markings of the inner layers are not preserved. The shell is strong and thick in advance of the center. It is made up of the thin, outer surface layer and several inner layers, as lamellæ, in the posterior portions that are slightly oblique to the outer surface. After the shell has attained a size of 2 or 3 mm., the lamellæ are more oblique to the outer surface and form a thick, strong shell, the outer edges of which often produce a rather rough surface.

The largest ventral valve in the collection has a length and breadth of 10 mm.; a dorsal valve 10 mm. in length has a width of 11 mm. The only interior portion of the shell known is on a fragmentary ventral valve, in which the visceral area does not reach the center, and the main vascular sinuses are about halfway between the center and the lateral margins of the valve.

Observations.—The general form and character of the shell is much like that of *O. loperi*. It differs from the latter in surface characters.

Formation and locality.—Middle Cambrian. Solomon Formation, 235 feet above Tonto sandstone, Grand View Trail, southern side of Grand Canyon, Arizona.

OBOLUS (WESTONIA) WIMANI, new species.

Lingula ? sp. Nos. 1 and 2. *Lingulella* ? sp. No. 7, WIMAN, Bull. Geol. Institute, Upsala, No. 2, VI, 1903, Pt. 1; Studien Nordbaltische Silurgebiet, pp. 51, 52; pl. II; figs. 30, 31, 32, 36.

The general form of this species is not unlike that of *O. (Westonia) bottnica*. The cardinal slopes of the ventral valve are more rounded, which makes the valve broader near the center. All of the specimens are also smaller. The surface markings are of the same character as those of *O. (Lingulella) finlandensis* and *O. (Westonia) bottnica*.

It is not improbable that with the discovery of a large series of specimens the three species may be combined, or *O. (Westonia) bottnica* and *O. (Westonia) wimani* placed as varieties of *O. (Westonia) finlandensis*.

The species is named after Dr. Carl Wiman.

Formation and locality.—Middle ? Cambrian. Fine gray sandstone, drift boulders at Biludden, shore of Gefle Bay, Sweden. For reference to geological horizon refer to description of *O. (Westonia) bottnica*.



ON THE GENERIC CHARACTERISTICS OF PRIONOTUS STEARNSII.

By THEODORE GILL,
Honorary Associate in Zoology.

During an examination of various species of Triglids, undertaken to ascertain their most salient characters, I was struck by the differences from others manifest by the *Prionotus stearnsii*. A more detailed comparison convinced me that it represented an independent generic group which may be named *Colotrigla* on account of the curtailment of the pectoral fins and free rays. The following comparative diagnosis, relieved of all superfluities, has been prepared with the species of *Prionotus* and *Trigla* before me.

COLOTRIGLA.

Prionotus sp. GOODE, BEAN, JORDAN and EVERMANN.

Triglids with the scales uniform, head with almost smooth bones, jaws exerted and even or lower prominent, supramaxillaries exposed,

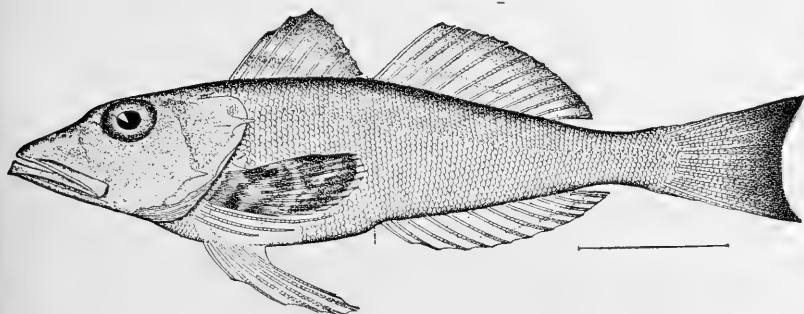


FIG. 1.—COLOTRIGLA STEARNSII. (AFTER JORDAN AND EVERMANN.)

teeth on jaws, vomer and palatines, spinous dorsal weak, pectorals very short, and free rays weak and not specially formed for use in progression or sensation.

The brevity of the pectoral fins or "wings," which so contrasts with the elongation in the true *Prionoti*, at once arrests attention, but would not perhaps be sufficient alone to demand recognition by

generic differentiation were it not accompanied by others entirely independent of teleological adaptation. The comparatively unarmed and smooth head and the prominent jaws are such irrelative deviations from the typical Trigline type. The most noteworthy character, however, is that manifest not only in the pectoral fins and rays, but in their mode of insertion; the basis of insertion is much reduced, so that the free rays are quite removed from the under thoracic surface as well as ventral fins. In striking contrast with this is the condition in the *Prionoti* as well as *Triglæ*, which have the free rays thickened and differentiated from the others by the tendency to decurvature forward, the wide base of attachment, and the insertion of the lowermost ray in front of the ventral's base.

The comparatively unarmed head is one of the most observable features. The only distinctive spines are the opercular and preopercular; the postorbital ridge is spineless and truncated behind and the other spines obsolete or not represented even by vestiges. It is the obsolescence of the preorbital spines that gives the peculiar physiognomy of *Colotrigla*.

The only species is the *Colotrigla stearnsii* originally described by Jordan and Swain in 1884^a as *Prionotus stearnsii*. In contrast with the characteristics of *Colotrigla* are those of *Prionotus* as now limited.

PRIONOTUS.

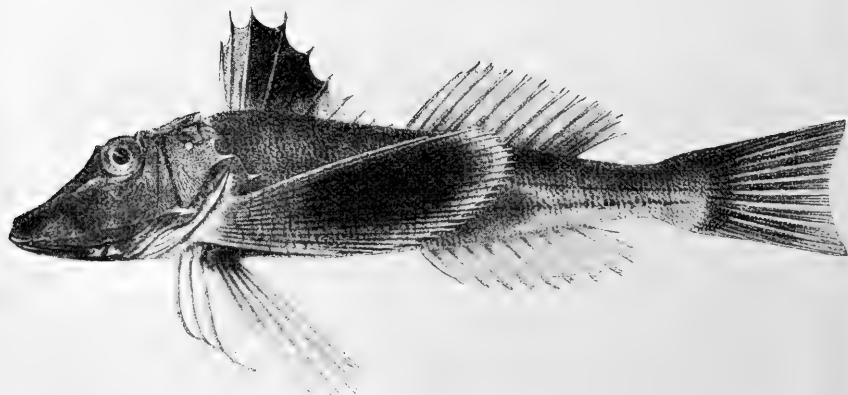


FIG. 2.—PRIONOTUS CAROLINUS. (AFTER STORER.)

Prionotus LACÉPÈDE, Hist. Nat. Poiss., III, 1802, p. 37 (*evolans*).

Orniethys SWAINSON, Nat. Hist. Fishes, etc., II, 1839, p. 262 (*punctatus*).

Chriolæ JORDAN and GILBERT, Proc. U. S. Nat. Mus., I, 1878, p. 374 (*evolans*).

Gurnardus JORDAN and EVERMANN, Syn. Fishes N. A., p. 2148 (*gymnostethus*).

Merulinus JORDAN and EVERMANN, Syn. Fishes N. A., p. 2149 (*carolinus*).

Trigla sp. LINNÆUS, 1758.

Triglids with the scales uniform, head with deeply sculptured bones, jaws mostly concealed under the projecting preorbitals and lower

^aProc. U. S. Nat. Mus., VII, 1884, p. 541.

shortest and closing within upper, supramaxillaries mostly retractile under preorbitals, teeth on jaws, vomer and palatines, spinous dorsal strong and highest at third or fourth spines, pectorals more or less elongated and extending half way or more to caudal, and free rays thickened and modified for progression as well as sensory functions.

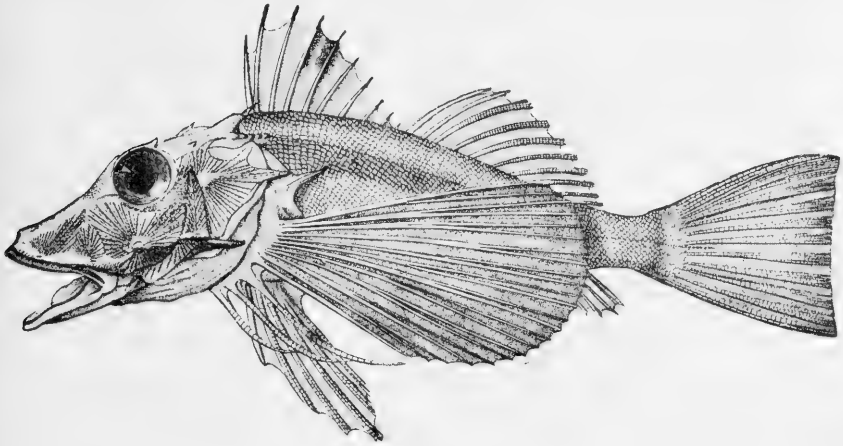


FIG. 3.—*PRIONOTUS STRIGATUS*. (AFTER CUVIER AND VALENCIENNES.)

The thick free pectoral rays are used in progression and their ordinary position is well illustrated in a figure published by Saville Kent in 1883, the best to be found in any work; it is an illustration of the

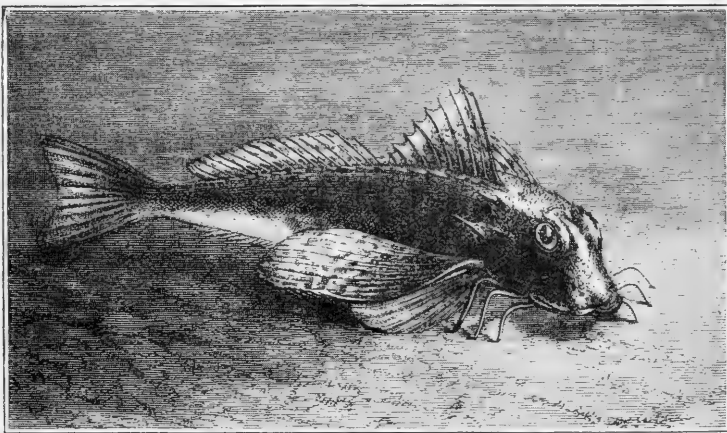


FIG. 4.—STREAKED GURNARD (*Trigla lineata*) IN CHARACTERISTIC TRIGLOID ATTITUDE. (AFTER T. SAVILLE KENT.)

“Streaked Gurnard” of England (*Trigla lineata*) and exactly reproduces the attitude of *Prionoti* as observed by myself, both in nature (along Long Island and Woods Hole) as well as in aquaria. The figures of Triglids here reproduced have been all conventionalized and give no idea of the carriage of the rays in life. That of *P. strigatus* is

here given, as no original illustration of it has been published in any American work.

The free rays of *Colotrigla*, inserted high up as they are and quite slender, could not be used in this manner.

There is another species of Triglid, referred to *Prionotus* by previous authors and much more nearly related to the typical species than the *P. stearnsii*, which exhibits a remarkable deviation from all the other species of that genus; it is the *P. alatus*. Each pectoral fin is divided into two parts, an upper of 7 or 8 rays diminishing downward, and a lower of 6 or 7, whose uppermost ray is very long and the lower rapidly graduated downward. This singular character is worthy of subgeneric recognition at least, and the subgenus may be named *Pissala*.

THREE NEW FROGS AND ONE NEW GECKO FROM THE PHILIPPINE ISLANDS.

By LEONHARD STEJNEGER,
Curator, Division of Reptiles and Batrachians.

Dr. E. A. Mearns, U. S. Army, has recently returned from the Philippines with large collections, which he has generously placed at the disposal of the United States National Museum. Among the herpetological material, which contains many valuable additions of genera and species to our collection, and sheds considerable light on many obscure points relating to this part of the fauna of the islands, there are a few undescribed species which it has been thought desirable to define and name in advance of a general report on the collection.

RANA MEARNSI,^a new species.

Diagnosis.—Tip of digits developed into regular disks, those of the fingers very large; a narrow, glandular dorso-lateral fold; vomerine teeth behind the level of the choanæ; interorbital space broader than upper eyelid; tympanum more than three-fourths the diameter of eye; first finger much shorter than second; tibio-tarsal articulation reaches considerably beyond the snout; a distinct tarsal fold; skin of belly and femur glandular.

Habitat.—Mindanao, Philippine Islands.

Type.—Cat. No. 35258, U.S.N.M.; Baganga River, East Coast Range Mountains, Mindanao; altitude between 1,000 and 5,000 feet; Dr. E. A. Mearns, collector; April 28 to May 7, 1904.

Description of type.—Vomerine teeth in two oblique groups, commencing on a line with the hinder edge of the choanæ; head moderate, elongate, rather pointed, the snout considerably longer than the diameter of the orbit; nostrils near tip of snout, their distance from eye equaling the diameter of the latter; interorbital space broader than upper eyelid; canthus rostralis well marked; lores concave; tympanum very distinct, about five-sixths the diameter of the eye; fingers very

^a Named in honor of its discoverer, Dr. Edgar A. Mearns.

long, the length of the third finger, including the metacarpal bone, equals the length of the third toe from tarsal joint; fourth finger much longer than second, which is much longer than first; disks on second, third, and fourth fingers very large, pointed anteriorly, that on first finger much smaller, not larger than the disks of the toes; hind legs long, the tibio-tarsal articulation of the extended leg reaching considerably beyond the snout; length of tibia more than one-half the total length of head and body; toes nearly entirely webbed; disks well developed but small, about the size of those of first finger; a feeble inner metatarsal tubercle about one-fourth the length of the first toe; a slight indication only of an inner metatarsal tubercle; the sharp outer dermal edge of the fifth toe continued along the tarsus as a distinct fold; a distinct, but very narrow dorso-lateral glandular fold; no fold behind tympanum; skin smooth above, with a distinct patch of minute pointed pustules on the posterior two-thirds of the upper eyelid, and a similar one, with the pustules somewhat wider apart, above the tympanum; throat and breast smooth, but sides, belly, and posterior lower surface of femurs rather coarsely granular. Color (in alcohol) above uniform olive green; a very strongly contrasted narrow yellow stripe beginning on the tip of the snout, following the canthus rostralis, outer edge of upper eyelid and the whole length of the dorso-lateral fold to the groin; underneath this yellow band, on the snout and lores, a dark purplish-brown band, which widens behind the eye so as to include the whole tympanic region; whole edge of upper lip to behind angle of mouth yellowish; a narrow yellowish line, following a slight glandular fold on the outer lower edge of the forearm; a narrow yellowish line, sharply marking the outer dermal edge of the fifth toe and the tarsal fold to the heel; posterior aspect of femur obscurely dark purplish gray, sending upward a triangular projection to include the vent; below the latter, in the dark area, two sharply defined and strongly contrasting pale yellow round spots, one on each side of the middle line; indications of obscure, dusky crossbars on the hind limbs; lower surface uniform pale yellow.

Dimensions.

	mm.
Total length, tip of snout to vent.....	62
Width of head	19
Length of longest finger, including metacarpal	20
Femur, from vent to knee	32
Tibia	35
Length of hind foot from heel to tip of longest toe.....	46

Remarks.—The unique type is exceedingly brittle, so much so, in fact, that it has actually been broken in two, but is otherwise in excellent condition, and the characters are shown very distinctly. Doctor Mearns, on the trip across the East Coast Range unfortunately had no other fluid which he could use in preserving the few specimens he was

able to collect than some blackberry brandy. The colors of this specimen seem to have kept very well.

This new species appears to be nearly related to *Rana temporalis*. Several other species belonging to the same group have recently been described from other Philippine islands. From these it differs in several marked structural and color characters.

CORNUFER WORCESTERI,^a new species.

Diagnosis.—Disks of fingers well developed; tibio-tarsal articulation reaching the nostril; tongue without papilla; occiput flat; whole underside, including throat, granular; tympanum about one-half the width of the eye; first finger shorter than second.

Habitat.—Mindanao Island, Philippine Islands.

Type.—Cat. No. 34784. U.S.N.M.; Mount Apo, Mindanao; Dr. E. A. Mearns, collector.

Description of type specimen.—Vomerine teeth in two oblique series behind the level of the hinder edge of the choanæ; orbital diameter slightly less than distance of orbit from tip of snout; interorbital space considerably wider than upper eyelid; canthus rostralis rounded; lores concave; crown flat; tympanum nearly circular, about one-half the diameter of the eye; finger free, first considerably shorter than second, which is shorter than fourth; disks rather large; toes webbed at the base; disks well developed, though not quite so large as on the fingers; hind limb being carried forward, the tibio-tarsal joint does not reach the tip of the snout, only to about the nostrils; skin smooth above (possibly with some longitudinal folds, but that can not be decided on account of the state of the specimen), coarsely granular on the whole underside, including the throat; a distinct tubercle on the upper eyelid. Color above pale brownish gray with small, irregular dark brownish spots; snout decidedly brownish; a very distinct blackish brown band across the top of the head at the anterior end of the upper eyelids, involving them and continuing below the eye to the edge of the lip; tympanic region dark, but loreal region pale brown as the snout and without dark stripe; underside pale, finely dusted over with brownish; limbs with traces of dark cross bars.

Dimensions.

	mm.
Total length	28
Width of head.....	12
Length of fore limb.....	17
Length of hind limb from vent to tip of longest toe.....	45

Remarks.—The unique type specimen is in an indifferent state of preservation, but its many distinct characters make it imperative to recognize it as a new species.

^a Named in honor of Hon. Dean C. Worcester, secretary of the interior of the Philippine government.

In some respects it seems to come closest to *C. jagorii* of Peters, from Samar Island. It differs from it in many important respects. The disks of fingers and toes appear to be larger, those of the fingers being particularly large, though not quite so large as in *C. dorsalis* from Fiji; the webbing between the toes is also more extended, being fully as large as in the latter species; the hind legs are also shorter, and the skin of the upper parts is smooth, though whether there are longitudinal glandular folds on the back can not be decided on account of the condition of the specimen.

The coloration seems also to be characteristic, since no mention of the distinct frontal cross band is mentioned in the description of any other species of this genus.

PHILAUTUS^a WOODI,^b new species.

Diagnosis.—Fingers free; toes webbed at base only; tibio-tarsal articulation reaching beyond tip of snout; snout pointed, conical, projecting, longer than diameter of eye; skin shagreened above, coarsely granular below, even including the under surface of limbs and feet; tympanum scarcely distinguishable; a strong glandular fold from eye to shoulder; no dorso-lateral fold; disks of digits large.

Habitat.—Mindanao, Philippine Islands.

Type.—Cat. No. 34781, U.S.N.M.; Mount Apo, 6,000 feet altitude, Mindanao; June 30, 1904; Dr. E. A. Mearns, coll.

Description of type specimen.—Snout longer than diameter of eye, with a pointed conical projection forming a distinct "nose;" nostrils located nearer the tip of the snout than the eye; canthus rostralis sharp; lores very concave, the concavity continued forward beyond the nostrils; interorbital space wider than upper eyelid; tympanum scarcely distinguishable, apparently not larger than half the diameter of the eye; fingers free, first considerably shorter than second, which is to the same extent shorter than fourth; disks of fingers rounded, large, especially those of third and fourth fingers; toes webbed at base only; disks well developed, about the size of those of second finger; subarticular tubercles well developed; a small oval inner metatarsal tubercle, no outer; no tarsal fold; hind legs being carried forward along the body, the tibio-tarsal articulation reaches a considerable distance beyond the tip of the snout; skin finely shagreened above, coarsely granular on the entire lower surface, including the throat, underside of limbs, and even the hands and feet; a strong glandular

^a *Philautus* Gistel, Naturg. Thierr., 1848, p. x, must take the place of *Ixalus* Duméril and Bibron, 1841, which is preoccupied by Ogilby, 1836, for a genus of mammals.

^b Named in honor of Major-General Leonard Wood, U. S. Army, president of the Philippine Scientific Association.

fold from eye to shoulder; no dorso-lateral fold. Color (in formalin and transferred to alcohol) above dark chocolate brown, with a hair-fine pale line from tip of snout along the entire middle line of the body; snout from tip to a line across the middle of the upper eyelids pale cinnamon in strong contrast; a large dusky mark behind this pale area on the interorbital space and involving the upper eyelids, though visible only with difficulty on account of the dark color of the rest of the upper surface; whole loreal and temporal area dark brown, apparently a shade darker than the back; flanks, anterior and posterior aspects of thighs, underside of tibia and foot with a strong suffusion of a deep saturated burnt sienna; underside whitish with a number of irregular spots or patches of brown; a few irregular white spots on the sides of the body.

Dimensions.

	mm.
Total length from tip of snout to vent	29
Width of head	12.5
Fore limb.....	19
Hind limb, from vent to tip of longest toe	55

Variation.—A second individual (Cat. No. 34782, U.S.N.M.) from the same locality agrees with the above in all essential structural characters. It differs in color, however, in so far as the entire dorsal surface is of the same pale color as the prefrontal area, so that the sides are marked by a very broad dark brown band from the nostrils backward. The transverse dark frontal band consequently also stands out in strong contrast.

Remarks.—In some respects this new species resembles *Ixalus leitensis* of Boulenger, with which it is probably most nearly related. It differs in many points, however, especially in the long, acuminate, and projecting snout and the lesser extent of the webbing of the toes. The color is also different in many essentials.

The following species of the genus *Philautus* are now known from the Philippine Archipelago:

1. *Philautus schmackeri* (Boettger), from Mount Halcon, Mindoro.
2. *Philautus longicrus* (Boulenger), from Palawan.
3. *Philautus acutirostris* (Peters), from eastern Mindanao.
4. *Philautus bimaculatus* (Peters), from the upper course of Argusan River, Mindanao.
5. *Philautus leitensis* (Boulenger), from Leyte.
6. *Philautus mindorensis* (Boulenger), from Mount Dulangan, 5,000 feet altitude, Mindoro.
7. *Philautus woodi* Stejneger, from Mount Apo, Mindanao.

LEPIDODACTYLUS PLANICAUDUS, new species.

Diagnosis.—Closely allied to *Lepidodactylus lugubris*, but tail much more depressed, broader, less tapering, with a lateral flap-like free margin and less distinct verticillate arrangement of the caudal scales; digits wider in proportion to their length.

Habitat.—Mindanao, Philippine Islands.

Type.—Cat. No. 34746, U.S.N.M.; Mount Apo, Mindanao, between 4,000 and 6,000 feet altitude; Dr. E. A. Mearns, collector; June–July, 1904.

Remarks.—Peters has already described a *Lepidodactylus labialis* from Mindanao, which is also said to be closely allied to *L. lugubris*. It has, however, a "cylindrical tail," and differs from it, consequently, in just the opposite way of our new species. In the latter the tail is unusually depressed and instead of tapering gradually toward the tip, the edges are practically parallel for quite a distance and then tapering off much more quickly. Instead of the "sharpish" lateral edge of the Polynesian *L. lugubris*, our specimen has a lateral free margin edged with a series of nearly uniform small spines which show no definite verticillate arrangement. The digits are wider and clumsier, hence look shorter than in *L. lugubris*, and the laminae under the basal joints are better defined. There are 12 upper and 11 lower labials, much as in *L. lugubris*, consequently less than in *L. labialis*. The first series of slightly enlarged chin scales which join the mental and the anterior lower labials are rather smaller than the next row, while in *L. lugubris* the proportion is reversed, those nearest the mental being the largest.

Dimensions of type specimens.

	mm.
Total length	78
Tip of snout to vent	41.5
Vent to tip of tail (extreme end reproduced)	36.5

DESCRIPTIONS OF NEW SPECIES OF TORTRICID MOTHS, FROM NORTH CAROLINA, WITH NOTES.

By WILLIAM DUNHAM KEARFOTT,

Montclair, New Jersey.

I am indebted to my friend, Dr. Harrison G. Dyar, for the opportunity of working up a most interesting and remarkable collection of Tortricids, made by Mr. W. F. Fiske during the summer of 1904 in Tryon, North Carolina. In a total of only 80 specimens there are nearly 50 species, of which about a dozen are, to the best of my belief, new to science. The specimens were taken at light, flying into the open windows during the evenings.

This list covers the entire collection made by Mr. Fiske, excepting a single specimen each of two species. I think both are new, but as I am unable to find duplicates in my unnamed material I hold them back for next year's catch, as it is undesirable to make species from single examples, if it can possibly be avoided.

EVETRIA GEMISTRIGULANA, new species.

Head, palpi, and thorax light gray, speckled with fuscous and black; the darker shades predominating on outer sides of palpi and patagia. Antennæ light gray, annulated with black, very shortly ciliated in male. Palpi short, scarcely extending beyond face, porrect; outer joint short, black, exposed; tuft on second joint flattened, neither compressed or loosely scaled, longer on upper than lower side. Forewing pale, rather lustrous gray, crossed transversely by many interrupted lines and narrow bands of black. The gray appears to be laid on a black ground rather than the reverse, and the gray lines are usually in pairs. In basal area, which is not very distinctly defined, occupying the inner quarter, three geminate white lines are more or less fused together; beyond, to the outer margin, they are more distinctly in pairs, of which, between inner fourth and apex, are about six on costa, extending a third or half the width of wing; below these other abbreviated pairs continue to the dorsal margin, but, excepting one line just before the outer marginal lines, none continue unbroken from costa to dorsum. There is a tendency in several specimens for

the black to overrun the gray in three rather distinct spots, two on costa, one beyond middle, and one before apex, and on dorsum half way between the two costal spots. A rather large triangular black spot on the extreme apex, and between it and the base the costa is rather evenly marked by alternate gray and black, about twelve to fifteen of each. This number is reduced on the specimens with large black costal blotches. Of the four specimens before me no two are exactly alike in the proportions of light and dark colors, nor is the lineation sufficiently duplicated to describe one in detail as the type. Cilia gray. Hind wing, upper and lower sides dark gray, cilia paler. Under side front wing dark fuscous, with whitish costal and dorsal marks repeated from above. Abdomen and anal tuft gray. Expanse 19 to 21 mm. Four male specimens May 17 to 25; collected by Mr. Fiske, Tryon, North Carolina.

Cotypes.—Cat. No. 8238, U. S. Nat. Mus., and in my collection.

I place this species temporarily in *Evetria*, as it seems nearer to it than any other familiar to me. Veins IV and V of front wings are not connate; they arise separately, but very close together. Veins III and IV of hind wings are stalked for half their length. No costal fold in the male. The frenulum fold on under side of forewings extends to outer three-fifths.

POLYCHROSIS LIRIODENDRANA Kearfott.

One female, August 8. Exactly like type and easily recognized by the reddish-ocherous appearance of the forewings.

OLETHREUTES HEBESANA Walker.

Three specimens, May 9 and August 13.

PSEUDOGALLERIA INIMICELLA Ragonot.

One male, July 7.

EUCOSMA QUINQUEMACULANA Robinson.

One male, no date of capture.

EUCOSMA ROBINSONIANA Grote.

One female, June 4.

EUCOSMA ROBINSONIANA Grote var **TRYONANA**, new variety.

Head and thorax pure white; a collar of olive brown divides head from thorax, crosses shoulders of patagia and runs into the ground color of forewings on the costa. Palpi white, inwardly and above, fuscous outwardly. Antennae pubescent, light gray, narrowly darker between joints, enlarged basal joint pure white. Forewing pale olive brown, with two white spots on outer half of costa, each inclosing a

small dot of ground color; two vertical white fascia arising from inner half of dorsal margin, but reaching only to upper vein of cell; a large white spot in anal angle with a small round white spot before and beyond it, these two being sometimes joined to the large spot; a small white spot on outer margin below apex and a tiny white patch at extreme base, a continuation of the white scales of thorax. These white spots are all narrowly bordered by darker-blackish lines. Cilia dull fuscous. Hindwing fuscous, cilia paler. Underside: forewing dull smoky fuscous, with white spots on costa faintly repeated from above, cilia same; hindwing slightly paler than fore wing. Abdomen fuscous, anal tuft cinereous. Legs white, annulated with olive-brown. Expanse 16.5 to 17.5 mm. Three male specimens. Tryon, North Carolina, collected by Mr. Fiske, May 17 to June 1.

Cotypes.—Cat. No. 8239, U. S. Nat. Mus., and in my collection.

It differs from *robinsoniana* in larger size, paler ground color, and especially in the white spot at anal angle, which is, in this variety, a cluster of three or four smaller spots, more or less joined, while in *robinsoniana* this spot is simple and covers less than one-third of the area. In Bulletin 52, U. S. National Museum, *robinsoniana* is made a synonym of *quinquemaculana* Robinson. But a study of the types at the Academy of Natural Sciences, Philadelphia, and the possession of a long series of both forms convinces me of their distinctness. *Quinquemaculana* differs from either of the above by: Head, thorax, and palpi brown, not white; position of two inner bands not the same; the inner is a basal patch and the second one is double the width and reaches to the costa. The outer costal spots do not inclose a dot of ground color and are of different shape and size, which is also the case with the spot on anal angle, and most notably all the spots of *quinquemaculana* are silvery white, while those of *robinsoniana* and *tryonana* are dull white. I have male and female of both Robinson's and Grote's species, and they show no sexual difference.

EUCOSMA ADAMANTANA Guenée.

Three specimens, September 1. Both Mr. E. Daecke and I have taken this species early in September, near Hammonton, South New Jersey, and I believe these and Mr. Fiske's captures are the first that have been made since Guenée's time; as his description^a is not readily accessible, it will be of interest to add that the species can be at once recognized by the almost perfect rusty-red cross on each fore wing, on a bright silver background. The longer limb of the cross arises on dorsal margin, close to base, and continues into apex, the cross-bar begins at center of costa and goes to anal angle. There is no other species of *Eucosma*, known to me, at all near this style of ornamentation. Mr. Daecke has most thoroughly worked this South New

^a Ann. Ent. Soc., Fr. (2), III, 1845, p. 303. (Type, from New Jersey.)

Jersey region, from earliest spring to late in the autumn, and, except in September, has never seen the species, it is therefore reasonable to assume that it is one-brooded, and I venture the assertion that the larvæ of this, as well as the majority of other silver-marked *Eucosma*'s, are borers or internal feeders.

EUCOSMA CIRCULANA Hubner.

One male, August 1. Exactly like Hubner's figure. Type was from Pennsylvania.

EUCOSMA PERGANDEANA Fernald.

One male, May 31.

EUCOSMA GRACILIANA, new species.

Head, palpi, thorax, and fore wings pale fawn brown. Outer ends of scales of palpi stained with fuscous.

Forewing.—Inner two-thirds of costa alternate short oblique lines of white and fuscous brown, in outer third same formation is continued, but ground color replaces the fuscous brown, and silvery metallic overlay the white. A vertical white line occupies the extreme apex, and on costa before and close to it are two other lines; the length of these three lines is nearly one-third the width of wing; the central one is most heavily metallic, while that on apex is simply dull white. Before this group of three vertical lines, and counting toward base, with apical spot number one, the fourth, sixth, and eighth are prolonged obliquely, then horizontally outward, the outer ends of the two former coming together, the extensions heavily overlaid with metallic. The ocellic spot is large, its inner side formed of a vertical metallic bar over one-third the width of wing; a similar bar defines the outward edge, but it is broken near lower end and slightly turns inward toward anal angle. Between these two bars are two narrow horizontal black lines, connecting them together at the top; a third line is indicated below by a few black scales. Above the ocellic spot on outer margin is a small metallic spot. All of the interior of the wing, below the costa and before the ocellic spot, is rather evenly dotted with metallic, arranged in rather straight horizontal lines, of which three lines are above and three below the fold. The dots in the subcostal line have a tendency to run together in groups of two or three; all others are separate. A scale or two of fuscous usually accompanies the metallic scales wherever they occur.

Male costal fold closely compressed, about one-fourth length of wing, a shade or two more tawny than general ground color. Cilia pale cinereous, heavily powdered basally with tiny black dots. Hind wing fuscous, cilia white, underside same, but a shade paler. Underside fore wing smoky fuscous, costa marked with dark blackish dots, cilia

pale cinereous. Abdomen fuscous, anal tuft cinereous. Legs pale cinereous, shaded with brown, tarsi annulated with brown. Expanse 16.5 to 19 mm.

Four males, Tryon, North Carolina. Two, May 20-22; two, July 3-24.

Cotypes.—Cat. No. 8240, U. S. Nat. Mus., and in my collection.

I have hesitated some time before describing this species, as there are several already described similar to it, and it seemed as though a place could be found for it. The nearest to it and their differences are as follows:

E. irroratana Walsingham is fawn colored, and is dotted with shining scales, but the interior scales are arranged in wavy lines, the ocellic spot contains a number of black dots—not bars, no reference in the description to the very distinct costal markings; 50 per cent or more larger; habitat California.

E. atomosana Walsingham is milk white, reticulated with fawn and irrorated with fuscous (not shining), only 10 to 20 per cent larger, but hailing from California.

E. catuclystiana Walsingham. This is a common Eastern species of about the same shade of brown, but the interior lustrous dots are entirely absent.

E. monogrammana Zeller is much paler, less dots, different ocellic and costal arrangement, and more nearly resembles *atomosana*.

E. albiguttana Zeller is very close, the marking is almost identical, but is only about half the size, the interior dots are arranged in four or five vertical rows and are far less numerous proportionately; the hind wings are paler, and the metallic lines around the ocellic spot somewhat different. Additional study may prove *graciliana* nothing more than a gigantic race of *albiguttana*, hence it should be placed next to it in the list.

EUCOSMA PALLIDIPALPANA, new species.

Head with long loose scales in front and on top, pale ochreish at base, pure white at tips; second joint of palpi clothed with long loose white scales, concealing third segment, shaded basally and outwardly with pale ochreish. Thorax dull ochreish. Fore wing pale fawn or dull ochreish. The ground color only in patches along dorsal margin, streaks along outer half of costa and before outer margin. The costa from base to apex is white, evenly marked with about sixteen short oblique grayish-brown dashes, arranged in eight geminated spots; a little beyond base a white transverse line is overlaid on its middle by brownish-fuscous. From about the inner third of costa another such line goes obliquely to the anal angle; at about the middle of the wing a right-angled spur from this to dorsal margin; half-way between this first spur and anal angle a second points toward costa, but

only reaches half-way through cell, where it runs into a large patch of brownish scales on the upper half of outer quarter. A narrow line of brown scales runs through upper half of cell from oblique line to outward patch. From the third from costa geminated spot a lustrous white line runs below the costa and before apex turns down to ocellic patch; from second spot before apex a shorter line of the same scales runs into the first line. Ocellic patch large, lustrous white inwardly, with two or three black dots on each side, a smaller white spot just below middle of outer margin and a smaller white dot below this, the latter only separated from the large white patch by a black line; above the latter and between the large patch and outer margin is a small round spot of ground color, nearly surrounded by narrow black lines; above it are three horizontal black dashes. There is a broken line of black scales dividing the upper white spot, thence running into anal angle through outer margin. The dorsal margin is narrowly, for its entire length, marked with white and fuscous scales, increasing to a triangular patch in the middle (where first spur runs into dorsum). The apical spot is flat triangular inclosed in white. Cilia and outer margin light gray, closely speckled with light brown. Hind wings fuscous, cilia paler, same beneath. Under-side forewing fuscous, with white costal dots repeated. Abdomen fuscous, legs whitish, tarsi annulated with light brown. Expanse 11.5 to 13.5 mm.

Nine specimens: Tryon, North Carolina (Fiske); Washington, District of Columbia, June and July (Busck); Fortress Monroe, Virginia, July 19 (Kearfott).

Cotypes.—Cat. No. 8241, U. S. Nat. Mus., and in my collection.

I should place this species in the *cataclystiana* group, and close to *imbricata* Fernald, which it somewhat resembles, but is much smaller.

EUCOSMA GIGANTEANA Riley.

Four specimens, August 5 to 27.

EUCOSMA JUNCTICILIANA Walker.

One male, August 13. Agrees with the Eastern form of this species, in which the oblique median line has a small outward hump about its middle, while all of the Northwestern and Californian specimens I have seen has this line perfectly even on its outer edge.

EUCOSMA ABRUPTANA Walsingham.

Three specimens: June 2, July 5, and August 18. These dates show a rather long period of emergence. The insect is probably single brooded and the larvæ borers or internal feeders like allied species.

EUCOSMA SCUDDERIANA Clemens.

One male, April 24 at light. Larvæ make round galls on stems of golden-rod.

EUCOSMA OTIOSANA Clemens.

One male, June 30. In the winter time, in all parts of northern New Jersey, the larvæ of this species can be found in the dried, previous summer's stalks of *Bidens frondosa* Linnaeus or beggar ticks, pupating within the stalk in May and issuing during June.

EUCOSMA DORSISIGNATANA Clemens var. **CONFLUANA**, new variety.

Dorsisignatana is deep chocolate brown, overlaid with grayish scales, except on two bold distinct separate spots—one on dorsum before middle and one on costa beyond middle. In variety *confluana* the two spots are joined together; the dorsal end is narrower, the whole representing rather an inflated comma. The ground color is also more of a reddish brown, and the hind wings are much paler. I have about forty specimens of the two forms in my collection, and the difference is constant; the spots are either entirely separate or joined. Clemens had this form before him when describing *dorsisignatana*, and described it under the name of *similana*, adding that it might be the female of the preceding. *Similana* is preoccupied in this genus, hence Clemens's name can not represent the variety; it is quite possible, however, after more is known about the Tortricids, that Hübner's species and Clemens's species may fall into different genera, when *confluana* will be superseded by *similana* Clemens. Expanse 18 to 21 mm. Twelve specimens, male and female. Essex County, New Jersey, August 24 to September 5 (Kearfott); Winchenden, Massachusetts, August 24 to September 1 (Merrick); New Brighton, Pennsylvania, August 28 to September 1 (Merrick).

Cotypes.—Cat. No. 8248, U. S. Nat. Mus., and in my collection.

EUCOSMA DORSISIGNATANA var. **DIFFUSANA**, new variety.

In separating the above another variety seems to be constant; it is of the dark chocolate form, but so heavily overlaid with gray scales that only the lower half of the dorsal spot is distinctly defined, all the balance of the forewing being an almost fuscous brown. Expanse 15 to 22 mm. Eleven specimens: Tryon, North Carolina, August 8 (Fiske); New Brighton, Pennsylvania, August 30 (Merrick); Vernon Parish, Louisiana, August (G. Coverdale); Newark, New Jersey, September 19 (Weidt); Charleroi, Pennsylvania, September 1 (Merrick); Essex County, New Jersey, September 16 (Kearfott).

Cotypes.—Cat. No. 8249, U. S. Nat. Mus., and in my collection.

EUCOSMA MINUTANA, new species.

Face and palpi cinereous, tuft on second joint outwardly rounded, third joint concealed; top of head, thorax, and forewing dark gray, minutely and closely dotted with cinereous. An oblique paler shade, from inner third of dorsal margin, defines the basal area; the line of demarcation is sinuate, with three outward and two inward indentations to middle of wing, where it disappears. Ocellic spot small, rounded, cream white, with a black horizontal dash about its middle which cuts through its outer side; another black dash on the upper edge, immediately above the lower. These two black dashes are so arranged that, under a glass, the white ocellic spot has the appearance of a compressed interrogation mark, or comma laid on its side, with the straight end pointing to the outer margin. Several other black dots partly surround the white spot—one, a dash, before it, and above the dash a smaller dot; another vertical dash defines the outer end of the comma. The costa—from inner third to apex—is marked with gradually increasing in size triangular oblique dark-brown dashes, each edged with cream white, irregularly arranged as four sets of geminate spots. The apical spot is cream white, divided by brown line; the costal spot before the apical sends a long, dark-bluish line obliquely to outer margin, then turns downward to top of ocellic spot, where it unites with a similar line out of apex. Cilia same as ground color, and with the space beyond the ocellic and subapical marginal lines forming quite a wide marginal band. Hind wing and cilia smoky brown, a shade paler beneath. Underside forewing dark brown, with whitish marks repeated on costa. Abdomen and legs gray, speckled with light brown, tarsi annulated with cinereous. Expanse, 9 to 14 mm. About forty specimens. Tryon, North Carolina, May 24–25, Fiske; Cincinnati, Ohio, May 21 to August 17, Miss Braun; New Brighton, Pennsylvania, May 20, Merrick; Plummers Island, Maryland, July, Busck; Belvidere, Illinois, August, Snyder; Smith County, Tennessee, June, Kemp; Anglesea, New Jersey, June 22, and Essex County Park, New Jersey, May 18, Kearfott.

Cotypes.—Cat. No. 8242, U. S. Nat. Mus., and in Miss Braun's, Mr. Merrick's, and my own collection.

I have long had these specimens mixed with *E. strenuana* Walker, which it is superficially much like, excepting very much smaller size. But, in addition to the size, it can be separated by grayer ground color, difference in ocellic spot, and arrangement of costal spots. Structurally, the forewings are more than three times as long as wide, much narrower than *strenuana*. The outer margin of forewing of both species is sinuate, thus differing from *E. circulana*, which is the type of the genus; and therefore when this cumbersome genus is divided, both of these species will fall into a different genus.

EUCOSMA SOMBREANA, new species.

Head very pale brown or bleached straw color, palpi brown, speckled with minute paler atoms, tip of third joint not exposed, thorax same as palpi. Forewing reddish brown, heavily dusted on inner half with cinereous. From middle of costa the cinereous scales form a straight line pointing to anal angle, but interrupted before middle, then continued to anal angle as golden metallic scales; at angle the metallic line is continued up along the outer margin to its middle, thence inward, and almost meets a spur of the middle line, altogether inclosing a vertical ovate section of the red-brown ground color. On costa beyond middle line are six more or less obscure oblique short lines of cinereous, the lower end of each becoming metallic. Entire length of costa cinereous speckled with brown and a preciliate line of the same. There is a very obscure broad paler transverse fascia beyond middle of wing, defined more clearly on the lower half, where it contrasts with a darker shade before it; other specimens are better described by saying that a darker shade rising from inner fourth of dorsum obliquely toward costa, but on cell coalescing with outer ground color. This dark shade is caused by the absence of the cinereous dots. Male costal fold very wide and three-fifths the length of wing. Cilia fuscous, speckled with whitish. Hind wing dark smoky brown, cilia paler, preceded and divided by paler lines. Under side forewing clay-brown basal and central part of wing, dull ochereous around edges. Hind wing dull ochereous. In other specimens the ground color of upper side of forewing is darker red-brown, almost purple brown, and the cinereous dusting less in evidence; the under sides of these darker specimens is almost a uniform dark brown, with slightly paler cilia. The females seem to be less cinereous and to have more metallic lines on outer half of costa and below apex, but as all before me are rather badly rubbed, this may not be true in fresh specimens.

Abdomen, fuscous mixed with cinereous scales. Legs dull ochereous, tarsi annulated with brown. Eight males, expanse 20 to 25 mm., four females expanse 20 to 23 mm. Tryon, North Carolina, July 14, Fiske; Chicago, Kwiat; Cincinnati, Ohio, August 2, Miss Braun; Scranton, Pennsylvania, July 26, Lister; Plummers Island and Cabin John Bridge, Maryland, August 1-10, Busek; Montclair, New Jersey, Electric Light, August 4, Kearfott.

Cotypes.—Cat. No. 8243, U. S. Nat. Mus., and in collections of Miss Braun, Mr. Lister, and my collection.

I think the larvæ of this species will be found to be a borer in the stems of possibly an annual plant, there seems to be a small race with both males and females about 20 mm., and a large race with both sexes from 23 to 25 mm. This can be accounted for by the supposition that some larvæ have lived in small and others in large stems. I would

place this species close to *E. dorsisignatana* Clemens, which it rather resembles in size, shape, and general robust appearance, superficially much like a moderate sized noctuid.

EUCOSMA RUSTICANA, new species.

Head, palpi, and thorax, shades of brown; face, inner and upper sides of palpi, light fawn brown; lower and outer edges of palpi and ends of scales on top of head, dark smoky brown; thorax and patagia light fawn, overlaid, especially anteriorly, with darker brown. Forewing the same shades of brown as above, the costal half dark smoky or blackish brown, the dorsal half and outer margin light fawn brown. The shades are not sharply divided and differ more or less in different specimens. The costa is darkest, and is marked by nine or ten black dots; between those on outer half are geminated streaks of a lighter shade. Below the costa the dark shades are in irregular horizontal lines from base to beyond end of cell, the dark color is rather concentrated at end of cell, and at the upper end is a small ovate pale line inclosing a black dot. The ocellic space is large, pale fawn, with one horizontal dark streak on its upper side in the male and two streaks in the female. Before this spot, running obliquely inward toward dorsal margin, is a line of dark scales. The dark shades almost entirely overlay the light shades on the dorsal half of the female from base to ocellic spot. Apex marked with a small rectangular pale fawn dot, with black dots before and below it. Cilia pale fawn, with three or four darker dots on upper half. Hindwing very dark smoky brown; cilia pale fawn, with a slightly darker line at its base. Under sides of both wings much like the upper sides, but the shades are more diffuse. Abdomen dark brown, anal tuft light brown. Legs pale brown, first and second pairs and tarsi of third, annulated with dark blackish brown. The male costal fold is rather narrow and not quite half the length of the wing.

Six specimens: Tryon, North Carolina, Fiske, May 13 and 22, August 1; Kerrville, Texas, Doctor Barnes; Algonquin, Illinois, June 4, Doctor Nason.

Cotypes.—Cat. No. 8244, U. S. Nat. Mus., and in my collection.

EUCOSMA FISKEANA, new species.

Head, thorax, and palpi cinereous brown, palpi with black tip of third segment visible, although scales of second joint project beyond it below, scales of palpi shaded with dark brown at tips and an oblique streak of same close to base on outer side.

Forewing ashy gray with dark brown fascia and spots. Basal area dark brown, overlaid with gray above dorsum, and strigulated with darker transverse lines, covers inner fourth of costa, angles outward to middle of wing, thence obliquely inward to dorsum, between latter and middle slightly indented. Beyond is an irregular oblique fascia

of ground color sharply defined only on upper half, strigulated with darker transverse lines. This shade really covers all of the wing beyond basal area, but interrupted as follows: In the middle of costa a triangular dark brown patch, its lower point reaching to median line; it is interrupted on costa by a pair of ground color lines, the inner curling inward and blocking off a rectangular costal spot of the dark color. Before the anal angle a triangular brown spot extends to middle of wing; it is separated from the costal patch by a broad band of ground color; it is darkest at its upper end and outwardly and upwardly defined by a paler luteous line. Arising from the anal angle and following outline of outer margin to middle, thence curving evenly inward beneath the costal spots, is a broad line, swelling out into a flattened ovate spot above, pale brown on its lower half, gradually becoming darker to the lunate spot, which is jet black. The ocellic spot between this and the dorsal triangular spot is luteous gray, with the flattened black dots in a vertical line; the upper one is the most constant and largest. The apical spot is moderate on costa, but extends down to nearly middle of wing on outer margin; between this spot and the rectangular brown spot on middle of costa are three large brown costal spots, separated from each other by geminated luteous lines, the line between third and fourth spots from apex (counting apical spot as number one) borders the outer spots below and runs into the outer margin, thence upward to apex, outlining the apical spot. Cilia gray.

Hindwing smoky-brown, cilia gray, divided by a slightly darker line. Under side forewing, dark smoky brown with paler geminations along costa and a paler shade before cilia which is cinereous. Under side hind wing grayish brown, reticulated transversely over its entire surface with darker brown lines. Cilia grayish brown with an outer and middle line of fuscous. Abdomen grayish brown, anal tuft dark brown. Legs same annulated and shaded with dark smoky brown. Expanse, male 23 to 24.5 mm.; female 29 mm. Two males, one female, Tryon, North Carolina, August 2-11. Collected by Mr. W. F. Fiske, whose name I take pleasure in giving to this species.

Cotypes.—Cat. No. 8245, U. S. Nat. Mus., and in my collection.

EUCOSMA CONSTRICTANA Zeller.

Two specimens, August 8. Differing from Texan specimens in my collection, the shades of which are reddish brown, in being shades of steel gray and black. Further material may prove these specimens to be a good variety or different species.

THIODIA RADIATANA Walsingham.

One male, May 1. Quite badly rubbed, but probably this species, or one of the closely allied, of which I have five awaiting opportunity for description.

ANCYLIS ALBACOSTANA, new species.

Head, on top, cinereous, mixed with ferruginous scales, a collar of whitish next to thorax, in front brown. Palpi cream white; ends of scales of second joint, which conceal the third joint, dark brown; a few scales of this color on outer sides of palpi. Antennæ cinereous. Thorax next to head a transverse band of lead color, another band of this color crosses the middle, each followed by a band of whitish. Patagia and thoracic tuft lead color at base, tips white. Fore wing lead color, rather heavily overlaid on inner two-thirds below the costa with brownish and blackish scales. From the base to the apex on the costa is a pure white band, widest at end of cell, where it is nearly a quarter the width of wing; continuing to base with only a trifle less width, and lower edge curving evenly into costa and ending in a point at apex. Below the white streak, on the inner half, are a number of small black dots; three below the fold are well defined, close together in a line in the second quarter; the inner one is single, the middle has a slight projection on the fold, and the outer one is double, its upper half being above the fold. Another black dot is on the upper gray edge, and is conspicuous against the white background above its upper half, before the inner fourth, and is connected by a darker streak with the inner of the three dots below the fold. Many other darker transverse streaks or strigulations cross the lead-color area. The ocellic area and outer margin below apex are dusted with white, a small, round, lead-color spot at anal angle and above it a vertical flattened ovate spot of same color; each are encircled by a line of whitish scales. The apex and the streak between this paler area and the white costal band is dark brown; in the apex is a small ocellus, a circle of black inclosing a dot of lead color and surrounded by dull ochreous. Cilia at apex cinereous, tinged with ferruginous, below apex pure white. Hind wings brownish fuscous above, pale fuscous below. Underside fore wing fuscous, whitish streak repeated along costa, cilia white below apex. Abdomen and legs fuscous, tarsi annulated with dark brown. Expanse 19 mm. Two female specimens: One Tryon, North Carolina, May 11, Fiske; one Colorado, National Museum, Accession Catalogue No. 45.

Cotypes.—Cat. No. 8246, U. S. Nat. Mus., and in my collection.

In describing this species from two females I run the risk of a generic error, but the falcate apex and venation agree with our definition of *Ancylis*.

ANCYLIS SEMIOVANA Zeller.

One male, May 20.

ANCYLIS DUBIANA Clemens.

One male, May 25.

ANCYLIS GOODELLIANA Fernald.

One male, May 7.

ANCYLIS DIMINUATANA, new species.

Head and thorax white, speckled with fuscous. Palpi white, tips of scales above and two spots on outside fuscous. Antennae golden brown. Fore wing creamy white; a seal-brown shade from base, over middle of wing to end of cell, thence to apex. The lower edge of this brown shade is sharply defined below, but diffuse and running into ground color above. Its lower edge begins at base close to dorsal margin and tends slightly upward to beyond middle of wing, thence acutely upward in a nearly straight line into apex. The lower edge is roundly indented twice on its inner half, where it turns up to apex and opposite the outer margin. It is outlined outwardly by a luteous-grayish line. This, opposite the ocellic spot, is succeeded by a light-brown line, and beyond and defining the ocellic spot is a short luteous-gray line. The ocellic spot is but a shade of brown. All the space along the dorsal margin and before the outer margin below the middle brown streak is ground color, overlain with gray and ferruginous scales. The dorsal margin is dotted with black. Above the brown shade on the inner half of costa is a streak of ground color, on which are three black dots in a line on upper vein of cell. At middle of costa a faint brown line runs obliquely into the brown shade; just below the apex, six other pale-brown lines on costa, between it and apex, start obliquely, but are all separated from the first by a paler line just below costa. These spots are separated by short gray or leaden lines, one just before apex being the best defined, and it is shaded on both sides by whitish brown. Cilia white immediately below apex, with a fuscous dot, below light fuscous with ferruginous tinge, preceded by a dark-brown line, and divided by a slightly darker fuscous line. Hind wing smoky fuscous; cilia paler. Underside fore wing smoky fuscous, whitish along costa, with a black apical dot and dash of white in the cilia below it. Hind wing pale gray; cilia same. Abdomen fuscous, anal tuft dull ochereous. Legs creamy white, washed with light brown on tarsi. Expanse 13.5 to 15 mm.

Twelve specimens: Tryon, North Carolina, May 12, Fiske; Winchenden, Massachusetts, May 26 to June 2, F. A. Merrick; Plummers Island, Maryland, and Washington, District of Columbia, May 19 to June 1, A. Busck; Ramapo, New York, May 27, Kearfott; Caldwell, New Jersey, May 17-22, Kearfott; Wellington, British Columbia, June and July 4, Doctor Taylor and Bryant; Denver, Colorado, April 23, Oslar.

Cotypes.—Cat. No. 8247, U. S. Nat. Mus., and in my collection.

In the National Museum there is a specimen of this species labeled "diminuatana Wlsm.," but I have not been able to find the name or a

description in any of Walsingham's writings. Should it, however, be on record, this additional description will not affect his title to priority.

This species is close to *goodelliana* Fernald, which latter is very close to European *biarcuana* Stephens, which is probably wrongly accredited to America. *Goodelliana* differs from *diminuatana* in its larger size (28 mm.), the brown streak narrower and almost obliquely to apex, and an additional brown line from base nearly to middle below the middle streak. My comparison is made from a specimen of *goodelliana* identified by Professor Fernald. I can not detect sufficient difference between Eastern and British Columbian specimens to warrant separation. The ground color of the latter is more of a silvery white, and the browns a shade darker; otherwise the maculation is the same.

ENARMONIA AMERICANA Walsingham.

Four specimens, May 25 and July 4-5. Agrees very closely with Walsingham's figures and description, except that the hind wings of the male are dark brown, the same shade as female. In Edward's collection, American Museum of Natural History, New York, are specimens from California, labeled *americana*, by Fernald, which are not the same as Walsingham's figure or these eastern species. I am under the impression that *americana* is found both East and West, while there is a closely allied but distinct additional species in California, which has been mistaken for it.

ECDYTOLOPHA INSITICIANA Zeller.

One male, May 26. Larvæ in September in galls on the twigs of common locust.

GYMNANDROSOMA PUNCTIDISCANUM Dyar.

One male, July 3; one female, May 14. The condition of the former is that it may have been on the wing for a month or more, which may account for the considerable difference in dates.

CARPOCAPSA TOREUTA Grote.

One male, June 1. This is a particularly interesting capture, as, so far as I know, the species has never been taken since Grote described it. It is not represented in any of the public or private collections that I have seen.

EPAGOGA SULFEREANA Clemens.

One male, June 4. Of the medium size northern form, with pale hind wings.

SPARGANOTHIS IRROREA Robinson.

One male, July 14.

ARCHIPS ROSACEANA Harris.

One male, August 8; one female, no date.

ARCHIPS PURPURANA Clemens.

One female, August 8.

PLATYNOTA FLAVEDANA Clemens.

One specimen, August 14.

PANDEMIS LIMITATA Robinson.

One male, June 3.

TORTRIX PERITANA Clemens.

One female, August 12.

TORTRIX FUMIFERANA Clemens.

One female, May 7.

TORTRIX CONFLICTANA Walker.

One male, May 2.

EULIA VELUTINANA Walker.

One male, August 14.

PHALONIA FERNALDANA Walsingham.

Two specimens, May 5-29.

PHALONIA BUNTEANA Robinson.

Two specimens, July 16.

PHALONIA NANA ? Haworth.

One specimen, August 14.

PHALONIA DUBITANA ? Hubner.

One specimen, August 12. I add an interrogation mark to this and the preceding species, as I am not by any means convinced that these European species occur in America.

PHALONIA ANGUSTANA Clemens.

One male, May 20. There is certainly no reason why Clemens's name should not have been restored long ago. Robinson made it a synonym of his *dorsimaculana*, supposing that *angustana* was preoccupied in this genus in Europe. The European species is not a *Phalonia*, but belongs to an allied genus *Eusanthis* Hubner. Besides other differences, Meyrick^a separates these genera by veins III and IV of hind

^a Hand Book of British Lepidoptera, p. 557.

wings stalked in *Euranthis* and separate in *Phalonia*, and gives figure of venation of this particular species, showing the stalked median vein. I also have eight European specimens in my collection, in all of which this vein is either short-stalked or connate. In the American *angustana*, as in all true *Phalonia*, veins III and IV are widely separated at base.

I think there is another mix up between *angustana* Clemens and *dorsimaculana* Robinson and *promptana* Robinson. The two latter were described at the same time, with very little difference either in descriptions or figures. I have not seen Robinson's types, but have carefully examined Clemens's type in Philadelphia, and from my present knowledge I would make *promptana* the synonym of *angustana* and leave *dorsimaculana* as a good but very closely allied species. I have long series, both male and female, of what I believe to be both species, and the most constant marks for separating them are the black dots on outer margin. *Angustana* has a single small dot just above the middle and a tiny one below the apex, while *dorsimaculana* has a marginal row of four horizontal black dashes. If further study should prove this analysis wrong, then both of Robinson's species may become synonyms of *angustana* and the species with the row of marginal dashes will have no name.

PHALONIA DORSIMACULANA Robinson.

Two specimens, July 10. See note above.

NOTE ON THE SALMON AND TROUT OF JAPAN.

By DAVID STARR JORDAN,
Of Stanford University, California.

In these Proceedings for 1902, Jordan and Snyder^a have given a review of the species of salmon and trout in Japan. Recently, Mr. T. Kitahara has published^b some useful criticisms on this paper, derived from his experience in the Imperial Bureau of Fisheries.

Mr. Kitahara is certainly right in thinking that the *Salmo perryi* of Brevoort is the trout called *Ito*, *Salmo blackistoni* of Hilgendorf. That species must therefore become *Hucho perryi* instead of *Hucho blackistoni*.

I think that Mr. Kitahara is also right in identifying the *Salmo masou* of Brevoort and the *Oncorhynchus yessoensis* of Hilgendorf with the common trout of Japan called Ame-no-uwo, Kawa-masu, or Yamabe, in its different stages of growth. This is the *Salmo macrostoma* of Günther, the species wrongly called *Salmo perryi* by Jordan and Snyder. This species should stand as *Salmo masou*.

Mr. Kitahara states that the humpback salmon (Karafuto-masu) in Japan as in America have black spots on the caudal fin. This species was not seen by Jordan and Snyder in Japan. The supposed humpback salmon or Yezomasu, figured by Jordan and Snyder as *Oncorhynchus masou*, was probably a dwarfish spawning female of *Oncorhynchus keta*.

Mr. Kitahara is probably right in regarding the Iwana, *Salvelinus pluvius* (Hilgendorf), the common charr or red-spotted trout of Japan, as inseparable from *Salvelinus malma*. *Salvelinus kundsha*, of the Kurile Islands, is however a different fish. The name *Salmo milktschitch* of Walbaum is earlier than *Salmo kisutch* Walbaum, and is based also on the silver salmon.

^a Proc. U. S. Nat. Mus., XXIV, 1902, p. 567, et seq.

^b Annotationes Zoologicae Japonenses, V, Pt. 3, 1904, pp. 117-120.

The species of Salmonidæ in Japan are therefore the following:

Oncorhynchus nerka (Walbaum); Beni-masu.

Oncorhynchus milktschitch (Walbaum); Gin-masu.

Oncorhynchus keta (Walbaum); Shaké or Saké.

Oncorhynchus gorbusha (Walbaum); Karafuto-masu.

Salmo masou (Brevoort); Masu, Ame-no-uwo, Yamabe.

Hucho perryi (Brevoort); Ito.

Salvelinus malma (Walbaum); Iwana, Ame-masu.

Salvelinus kundscha (Walbaum).

Plecoglossus altivelis (Schlegel); Ayu.

The king salmon *Oncorhynchus tshawytscha* (Walbaum) is not yet known from Japanese waters.

DESCRIPTIONS OF A NEW GENUS OF ISOPODA BELONG-
ING TO THE FAMILY TANAIDÆ AND OF A NEW SPECIES
OF TANAIS, BOTH FROM MONTEREY BAY, CALIFORNIA.

By HARRIET RICHARDSON,
Collaborator, Division of Marine Invertebrates.

About eight specimens of the two new species to be described were collected at Monterey Bay, California, by Mr. Harold Heath and sent to the United States National Museum. One of these species represents a new genus, *Pancolus*, the diagnosis of which is given below.

PANCOLUS, new genus.

Eyes present, distinct. First pair of antennæ composed of three articles. Second pair of antennæ composed of five articles. First thoracic segment permanently united with the head to form a carapace. The following six segments are free and distinctly separated. The abdomen is composed of only three segments, two segments anterior to the terminal segment. There are but two pairs of well-developed pleopoda. The uropoda are single branched and consist of a peduncle and a branch composed of a single article. The first pair of legs are chelate. All the following six pairs are ambulatory.

PANCOLUS CALIFORNIENSIS, new species.

Body narrow, elongate, $5\frac{1}{2}$ mm. long, and almost $1\frac{1}{2}$ mm. wide.

Head as wide as long, $1\frac{1}{2}$ mm. : $1\frac{1}{2}$ mm., with the anterior margin somewhat triangular between the eyes, which are placed in the extreme antero-lateral angles. The head anteriorly is about half as wide as it is posteriorly. The first pair of antennæ have the first article large and robust, about half as wide as long; the second article is half as long as the first; the third is a little shorter than the second and terminates in a bunch of hairs. The second pair of antennæ are shorter than the first, reaching only to the end of the second article of the first pair of antennæ. The first article is longest, being three times longer than the second; the third is about twice as long as the second; the fourth is more than one and a half times longer than the second; the fifth is minute and terminates in a bunch of hairs.

The first segment of the thorax is coalesced with the head to form a carapace. The second or first free segment is a little shorter than any of those following. The third and fourth or second and third free segments are subequal; the last three are subequal, and each is a little longer than either of the two preceding segments.

The abdomen is composed of three segments, two short ones followed by the terminal segment, which is rounded posteriorly. The uropoda

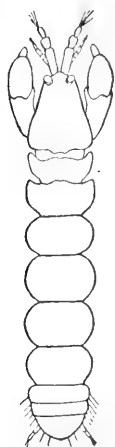


FIG. 1.—*PANCOLUS CALIFORNIENSIS*.
× 9.

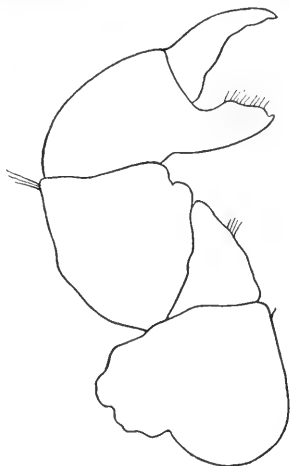


FIG. 2.—*PANCOLUS CALIFORNIENSIS*.
FIRST GNATHOPOD. × 20.

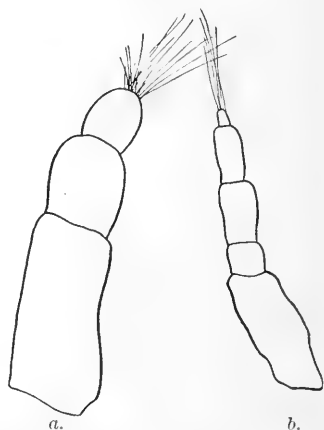


FIG. 3.—*PANCOLUS CALIFORNIENSIS*. *a*,
FIRST ANTENNA. × 44. *b*, SECOND AN-
TENNA. × 44.



FIG. 4.—*PANCOLUS CALI-
FORNIENSIS*. MANDIBLE.
44.

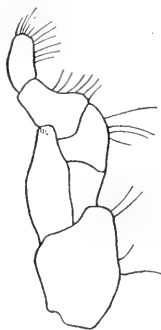


FIG. 5.—*PANCOLUS CALI-
FORNIENSIS*. MAX-
ILLIPED. × 44.



FIG. 6.—*PANCO-
LUS CALIFORNI-
ENSIS*. EPI-
GNATH OF MAX-
ILLIPED. × 44.

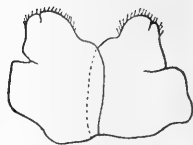


FIG. 7.—*PANCOLUS CALI-
FORNIENSIS*. POSTE-
RIOR LIP. × 44.

are single branched. The peduncle is short. The branch consists of a single article, tipped with long hairs. There are but two pairs of well-developed pleopoda.

The first pair of legs or gnathopods are chelate. The second pair of legs are long and feeble, but similar to those following, which are ambulatory, but more robust. The dactyli in the last three pairs are curved.

Six specimens of this species were collected by Mr. Harold Heath at Monterey Bay, California.

The types are in the U. S. National Museum. Cat. No. 30614, U.S.N.M.



FIG. 8.—*PANCOLUS CALIFORNIENSIS*. FIRST MAXILLA. $\times 44$.

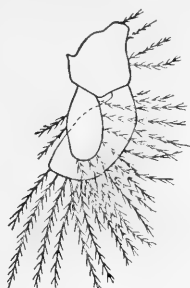


FIG. 9.—*PANCOLUS CALIFORNIENSIS*. FIRST PLEPOD. $\times 44$.

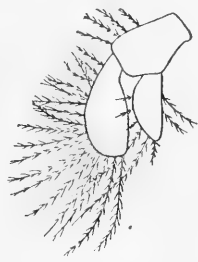


FIG. 10.—*PANCOLUS CALIFORNIENSIS*. SECOND PLEPOD. $\times 44$.

TANAIS NORMANI, new species.

Body narrow, elongate, 4 mm. long. : $\frac{3}{4}$ mm. wide.

Head as wide as long, with the anterior margin triangulate between the eyes, which are situated at the extreme antero-lateral angles.

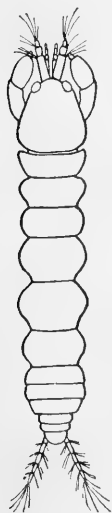


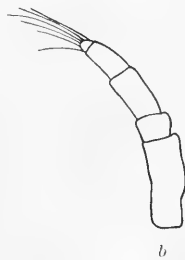
FIG. 11.—*TANAIS NORMANI*. $\times 11\frac{1}{2}$.



FIG. 12.—*TANAIS NORMANI*. FIRST GNATHOPOD. $\times 44$.



a



b

FIG. 13.—*TANAIS NORMANI*. a, FIRST ANTENNA. $\times 44$. b, SECOND ANTENNA. $\times 44$.

The head is half as wide anteriorly as it is posteriorly. The eyes are small, but distinct. The first pair of antennae are composed of three articles, and have the first article longest, about two and a half times longer than wide; the second article is half as long as the first; the third is a little shorter than the second, and terminates in a bunch of

long hairs. The second pair of antennae are composed of five articles and have the first article about three times as long as the second; the third is twice as long as the second; the fourth is one and a half times longer than the second; the fifth article is minute and terminates in a bunch of hairs.

The first segment of the thorax is united with the head to form a carapace. The second or first free segment is the shortest of all; the third and fourth or second and third free segments are nearly equal in length, the third being perhaps a little longer; the fifth and sixth or fourth and fifth free segments are subequal and are the longest; the sixth or seventh free segment is about equal in length to the third free segment.

The abdomen is composed of six segments. The first three are subequal in length and carry on the ventral side three pairs of well-developed pleopoda. The two following segments are subequal, and each about one-half as long as any of the three preceding segments and about one-half as wide, being abruptly narrower. These segments do not carry pleopoda. There are thus only three pairs of pleopoda. The sixth or terminal segment is as wide as the two preceding segments and is rounded posteriorly. The uropoda are single branched; the peduncle is followed by a five-articulate branch.

The first pair of legs or gnathopods are chelate. The following six pairs of legs are ambulatory.

Only three specimens of this species were collected by Mr. Harold Heath at Monterey Bay, California.

The types are in the U. S. National Museum. Cat. No. 30615, U.S.N.M.

This species differs from *Tanais alascensis* Richardson in having the abdomen composed of six segments, while in *T. alascensis* it is composed of five segments; in having the uropoda composed of a peduncle and five articles, while in *T. alascensis* the uropoda are composed of a peduncle and six articles; and in the smaller size of the specimens.

A CRITICAL REVIEW OF THE LITERATURE ON THE SIMPLE GENERA OF THE MADREPORARIA FUNGIDA, WITH A TENTATIVE CLASSIFICATION.^a

By T. WAYLAND VAUGHAN,
Custodian, Madreporian Corals.

INTRODUCTION.

CAUSES THAT LED TO THIS COMPILATION AND THE ATTEMPTED CLASSIFICATION.

The following paper has grown out of the necessities of my work on the fossil corals of North America and the study of the recent Fungid corals in the United States National Museum. In my *Some Cretaceous and Eocene corals from Jamaica*^b I had to describe simple Fungid corals belonging to three different genera; other species of Fungids had to be considered in my *Corals of the Buda Limestone (Texas)*^c; and they are well represented in collections of Tertiary corals that I am at present studying for the United States Geological Survey.^d

The last comprehensive attempt at the classification of these corals is that of Duncan, in his *Revision of the Families and Genera of the Madreporaria*.^e This work is very faulty, and is often insufficient for the determination of the genera described in it. I was therefore unable to identify the genera to which some of the specimens referred to me belonged, even after I had collected the descriptions of those proposed since 1884. Furthermore, the original generic diagnoses were often inadequate and type-species had not been designated—in fact, it not only seemed, but actually is, hopeless, to find in the literature the differential characters of many of the proposed genera.

^aPublished by permission of the Director of the U. S. Geological Survey.

^bBull. Mus. Comp. Zool., XXXIV, 1899, pp. 242-246.

^cU. S. Geol. Surv. Bull., No. 205, 1903, pp. 39, 40.

^dTertiary corals of North America. Part II. Faunas of the Post-Eocene formations of the eastern and southeastern United States and the Tertiaries of the West Indies, U. S. Geol. Surv. Mon., vol. ——. (In preparation.)

^eJourn. Linn. Soc. London, Zool., XVIII, 1884.

OBJECT OF THIS WORK.

I therefore decided to make a compilation of the original diagnoses of the various genera, to fix the type-species wherever possible, to supplement the original diagnoses by subsequent observations based primarily upon the type-species, to make a tentative classification, and, where the information concerning a genus or a group of genera is not sufficient for purposes of classification, to point out what should be done in order to make the genera recognizable. After having given the original diagnosis of a genus, designated its type-species, and stated its distribution, under "remarks" a historic sketch of the increase in knowledge concerning it and critical notes on it are given. The method is cumbersome, but, as this paper is primarily a critical review of literature, it seems to me to be the correct one.

THE NECESSITY FOR THE DESIGNATION OF TYPE-SPECIES.

Most modern systematic biologists will probably be surprised to see stated in a heading a principle that is all but universally recognized. Several of the older zoophytologists recognized the *necessity* of type-species for genera. Leuckart in 1841 did, Milne Edwards and Haime invariably designated a type-species, and Laube erected monotypic genera. Many of the later workers have not done this, making it extremely difficult to find out precisely how the genera should be defined. Investigations subsequent to the founding of a genus have frequently been based on some other species than the geno-type, and often not even the name of the species investigated is given. These studies have not infrequently been used in redefining a genus, giving rise to extreme confusion. The failure to base redefinitions of genera primarily upon type-species and the failure to give the names of the species upon which studies were based have invalidated some of the most painstaking work that has been done on corals.

The genus *Thamnasteria*^a Le Sauvage furnishes an excellent illustration. This genus was established for *Thamnasteria lamourouzi* Le Sauvage = ? *Astrea dendroidea* Lamouroux.^b The spelling of the name was subsequently changed to *Thamnastrea*, and is now usually spelled *Thamnastraea*. Pratz, in his Ueber die verwandschaftlichen Beziehungen einiger Korallengattungen,^c gives an elaborate description of the finer structure of a coral referred by him to *Thamnastraea*, but he does not give the name of the species. Duncan, in his Revision of the Families and Genera, utilized Pratz's work. Ogilvie, in her Korallen der Stramberger Schichten, did the same. Koby

^a Mém. Soc. d'Hist. nat., Paris, I, 1822, p. 243.

^b Expos. méthod. Genres Polyp., 1821, p. 85, pl. LXXVIII, fig. 6.

^c Palaeontographica, XXIX, 1882, pp. 92-98.

says, in his *Monographie des Polypiers Jurassiques de la Suisse*: “Je prends pour type des véritables *Thamnastrées* la *Thamnastræa arachnoides*.” Felix, in his *Anthozoen der Gosauseichten in den Ostalpen*, follows Pratz’s characterization of *Thamnastræa*. Gregory was the first one to make a careful study of Le Sauvage’s type-species, and published a description and figure of the septa.^a He says: “Three septa of this specimen are shown on Plate II A, figure 3. The septa are laminar and not trabicular. The figures which Pratz gives to represent the septal structure of *Thamnastræa* agree with those of *Dimorpharæa continua*. * * * Hence the *Thamnastræa* of Pratz is altogether different coral from the *Thamnastræa* of Le Sauvage. We must retain the name for the corals placed in it by Le Sauvage, and for those later described species, which have the same septal structure. Pratz’s *Thamnastræa* must be relegated to another family.” To another family! And every species referred by Felix in his beautiful work on the corals of the Gosau Cretaceous to the genus *Thamnastræa* is generically wrongly identified.

Blunders brought about by work like that of Pratz, in which type-species and specific names are ignored, are numerous. *Thamnasteria* is given as an example.

It can not be too strongly emphasized that *a correct understanding of genera is impossible unless the definitions are based primarily upon a single type-species*.

REVIEW OF WORK ON THE GENERAL CLASSIFICATION OF THE FUNGIDS.

Duncan published, in 1883,^b two articles on the *Fungida*—(1) Observations on the Madreporarian family (the *Fungidæ*), with especial reference to the hard structures, and (2) On the structure of the hard parts of the *Lophoserinæ*. In the first-mentioned article a history of the development of the knowledge of the *Fungidæ* is given. At the time of writing these articles Duncan apparently did not know of Pratz’s *Ueber die verwandschaftlichen Beziehungen einiger Korallengattungen*, which was published during the previous year.

Pratz’s work is among the finest that has been done on the hard parts of corals, and can be regarded as of epoch-making importance. He unfortunately did not realize the importance of type-species and fixing the particular species that he investigated.

Pratz divided the *Fungidæ* into five subfamilies—*Pseudoastræinæ*, *Pseudoagaricinæ*, *Agaricinæ*, *Funginæ*, and *Merulinæ*. The *Pseudoastræinæ* were divided into the *Regulares* and *Irregulares*. The following is the classification that he proposed:

^a Jurassic Fauna of Cutch, The Corals, 1900, pp. 134, 135, pl. II A, fig. 3.

^b Journ. Linn. Soc. London, Zool., XVII, pp. 137-162, pls. v, vi; pp. 302-319, pl. XIII.

I. Subfamily *Pseudoastræinæ*: "Corallum simple or compound. Septal apparatus trabecular, porous. Calices in the compound forms confluent, not separated by walls or by true cœnenchyma, but united by radial septo-costæ. Pseudosynapticula, or true synapticula, present alongside dissepiments."

Ia. *Pseudoastræinæ Regulares* (= *Thamnastræinæ* Zittel + *Cyclolitinæ* Verrill): "Trabeculae composed of regularly (symmetrically) grouped calcareous nodules, which are in contact at quite regular intervals, thus forming more or less uniformly distributed rows of pores that run perpendicular to the septal margins. Faces of neighboring septa united by pseudosynapticula and dissepiments."

The *Pseudoastræinæ Regulares* are divided into two groups:

1. Group: "With a pronounced tendency to form more or less compact septa through subsequent deposition of sclerenchyma. Septa not always and then only partially perforate."

GENERA: CYCLOLITES, LEPTOPHYLLIA, THAMNASTRÆA, ETC.

2. Group: "No tendency to fill the intertrabecular spaces through subsequent deposition of sclerenchyma. Septa fine, and regularly fenestrated."

GENERA: TROCHARÆA, MICROSOLENA, ETC.

Ib. *Pseudoastræinæ Irregulares*: "Trabeculae composed of numerous irregularly grouped calcareous nodules, which are irregularly fused. Therefore, the intertrabecular spaces (pores) are of very dissimilar size and are irregular in arrangement. Septa united by both true synapticula and dissepiments. The basal part of the septa is often compact."

GENERA: HAPLARÆA, COSCINARÆA, ETC.

II. Subfamily *Pseudoagaricinæ*: "Corallum compound, massive or incrusting, never foliaceous or lobed. Septal apparatus compact. Septa of neighboring calices confluent. Wall absent or rudimentary. No cœnenchyma. Well-developed dissepiments and true synapticula present."

GENERA: ASTRÆOMORPHA, MESOMORPHA, ETC.

III. Subfamily *Agaricinæ* Verrill (*Lophoserinæ* Milne Edwards and Haime): "Corallum simple or compound, in the second instance; always more or less foliaceous or lobed, never massive. Septa solid, united by synapticula and sometimes by dissepiments. Common [basal] wall not spinose."

IV. Subfamily *Funginæ* Milne Edwards and Haime: "Corallum simple or compound. Septa solid, united by synapticula. Common [basal] wall spinose."

V. Subfamily *Merulininæ* Milne Edwards and Haime: "Corallum compound, foliaceous. Septa confluent, united by dissepiments. Wall rudimentary. Common [basal] wall perforate."

The principal value of the contribution of Pratz is that it showed that valuable information could be obtained from a more detailed study of the septal structure. The terms proposed by him are cumbersome, and they do not conform to modern nomenclatorial rules; it is, therefore, inadvisable to use them at the present time.

The specimens that Pratz considered *Thamnastraea* have been shown by Gregory not to be *Thamnastraea* at all (see p. 373). *Thamnastraea* Lesauvage (originally *Thamnasteria*) belongs in Pratz's "*Pseudogariccinæ*." The distinction between the "*Pseudogariccinæ*" and "*Agariccinæ*" is probably not valid, as shown by a species of *Agaricia*, *A. crassa*, recently described by Professor Verrill.^a The septa of the *Funginæ* are often, the smaller one normally, perforate.

Pratz laid much stress on whether synapticula are what he calls true or false ("true," where a calcification center joins opposed granulations; "false," where they fuse directly). Such a division of these structures is of no systematic importance.^b

Duncan, in his Revision of the Families and Genera of the Madreporaria, divided the Madreporaria Fungida into five families, as follows:

"I. Family PLESIOFUNGIDÆ.

"This family unites more or less the *Aporosa* and *Fungida*.

"Fungida simple or colonial, with synapticula in the interseptal loculi, besides endothecal dissepiments. Septa solid and imperforate, occasionally irregularly perforate and trabeculate."

"II. Family FUNGIDÆ.

"(Subfamily *Funginæ* (part), EDWARDS and HAIME, Hist. Nat. des Corall., III, 1862, p. 4.)

"Simple or colonial forms, usually depressed, with the septa solid or occasionally porous. Synapticula crossing the interseptal loculi and uniting the septa without the presence of dissepimental endotheca. Wall more or less synapticulate or special, perforated and echinulate. Calices with radiating septa in the simple forms; with or without radiating lamellæ, along a central axial line, or scattered in the colonial forms. Tentacles short, scattered, sometimes obsolete.

"This family stands very much by itself, and its genera are remarkable for their calicular structures and developments."

^aTrans. Conn. Acad. Sci., XI, 1902, p. 145, pl. xxx, fig. 6; pl. xxxiv, fig. 2.

^bVon Koch, Das Skelett der Steinkorallen, Gegenbauer Festschrift, 1896, p. 260; Vaughan, Eoc. and Lower Oligoc. Corals, Mon. U. S. Geol. Surv., XXXIX, 1900, pp. 47, 48.

“III. Family LOPHOSERIDÆ.

“(Subfamily *Lophoserinæ* EDWARDS and HAIME.)

“Fungidæ in which the wall is neither perforated nor echinulate. Synaptacula exist, but not endothecal dissepiments. Septal laminae usually solid, but occasionally with ill-defined perforations, remote from the bottom of the septa.

“Very considerable changes have taken place in the old subfamily of Milne-Edwards and Jules Haime, the *Lophoserinæ*, owing to the introduction of new genera and the elimination of old ones in consequence of the necessity of founding the family Plesioporitidæ.

“There are two subfamilies—the *Lophoseridæ simplices* and *Lophoseridæ aggregatæ*.”

“IV. Family ANABACIADÆ.

“Madreporaria Fungida simple or colonial. Septa trabeculate and fenestrated. Synaptacula small. Dissepiments absent. Wall indistinct.”

“V. Family PLESIOPORITIDÆ.

“Fungida with trabeculate and regularly perforate septa. Synaptacula between the septal laminae in the interseptal loculi. Schlerenchyma trabeculate. Dissepiments may or may not exist. Wall existing or not, and imperforate. Epithecæ may exist and be well developed.”

M. Koby divided the Fungids described by him from the Jurassic of Switzerland into two families, *Thamnastréides* and *Microsolénides*.^a He unfortunately used the wrong species, *Thamnastræa arachnoides*, as the geno-type of *Thamnastræa*.

Frech, in his *Korallen der juvavischen Triasprovinz*,^b recognized among his material two families of Fungids, *Thamnastræidæ*, with two subfamilies, *Thamnastræinæ* and *Astræomorphinæ*, and a new family, *Spongiomorphidæ*. Frech was misled concerning the septal structure of the real *Thamnastræa*.

Ogilvie, in her Systematic study of the Madreporarian types of corals,^c considered the Madreporaria Fungida of only family importance and recognized three subfamilies, namely, *Funginæ*, *Thamnastræinæ*, and *Lophoserinæ*. Her *Thamnastræinæ* is based on Pratz's misconception of *Thamnastræa*.

A decided advance in the classification of the Fungida was made by

^aSchweitz. Pal. Gesellsch., Abhand., XVI, 1889, pp. 568, 569.

^bPalæontographica, XXXVII, 1890, pp. 59-79.

^cPhil. Trans. Roy. Soc. London, ser. B, CLXXXVII, 1897, pp. 342-343.

Gregory in his Jurassic corals of the Cutch." One reason for this advance of Gregory was, he carefully determined the type-species of each genus and was thus able to give reliable generic diagnoses. He proposed the following classification to cover the genera represented by the Cutch Jurassic corals.

"Order FUNGIDA.

"Madreporaria in which the walls and septa are perforate or imperforate. The septa consist of lamellæ or of palissades of trabiculæ. The septa are united by abundant synapticulæ. Dissepiments unimportant or absent.

"Family THAMNASTRAEIDÆ, Koby, em.

"Simple or compound Fungida, with lamellar septa, which are solid or perforated only along the upper or inner margins, owing to the fusion of trabicular projections from the septa. Synapticulæ and dissepiments both present.

"Subfamily 1: THAMNASTRAEINÆ.

"In compound coralla the septa of adjoining corallites are confluent. The corallites are not separated by collines or synapticular walls.

"Genera: *Thamnastraea*, LE SAUVAGE (not PRATZ).

"Genera: *Dimorphastraea*, D'ORBIGNY.

"Genera: *Centrastraea*, D'ORBIGNY.

"Genera: *Stibastraea*, ÉTALLON.

"Genera: *Latomacandra*, EDWARDS and HAIME.

"Subfamily 2: COMOSERINÆ.

"The corallites are surrounded by compact synapticular walls. The corallites may be free laterally at their distal ends or united into long series, externally bounded by collines.

"Genera: *Archaeoseris*, GREGORY.

"Genera: *Comoseris*, D'ORBIGNY.

"Family ETHMOTIDÆ, Gregory.

"Simple or colonial Fungida, in which the septa are lamellar; they are cribriform but not trabicular.

"Genera: *Protethmos*, GREGORY.

"Genera: *Metethmos*, GREGORY.

"Genera: *Frechia*, GREGORY.

"Genera: *Sematethmos*, GREGORY.

"Genera: *Kobyia*, GREGORY.

^a *Palæontologia Indica*, Ser. IX, Jurassic Fauna of Cutch, II, 1900, Part 2—The Corals, pp. 29, 30.

“Family MICROSOLENIDÆ, Koby, em.

“Simple or colonial Fungida in which the septa are palissades of more or less vertical, disconnected, regular or irregular trabiculæ.

“Genera: *Anabacia*, EDWARDS and HAIME.

“Genera: *Genabacia*, EDWARDS and HAIME.

“Genera: *Trocharaca*, ÉTALLON.

“Genera: *Trochoplegma*, GREGORY.

“Genera: *Microsolena*, LAMOUREUX.

“Genera: *Tricycloseris*, THOMES.

“Genera: *Dimorpharaca*, DE FROMENTIL.

“Genera: *Thannaraca*, ÉTALLON.”

BASIS OF THE CLASSIFICATION HERE PROPOSED.

Following the lines of the investigations of Pratz, Gregory, and others, the larger divisions are based upon septal structure; that is, whether the septa are solid or perforate; if perforate, whether they are more pronouncedly laminar or trabecular in composition, and I have also utilized in defining the families the character of the wall, whether normally perforate, even if only slightly, or whether normally solid. The genera are separated by columellar characters, the relative compactness of the septa, the presence or absence of paliform processes, costal characters (whether corresponding or alternating with the septa), and the epitheca. The value of the epitheca in separating genera has been severely attacked.^a Gregory says, “There is no part of a coral skeleton over which more time has been wasted than over the epitheca.” From a study of large numbers of species belonging to the same genus, I am inclined to believe that the so-called complete epitheca is, in some instances at least, a generic character. There are genera in which epitheca is normally absent, and others in which it may exist in an imperfectly developed condition. Epitheca can not be considered to possess the importance once attached to it, but I believe that its supposed value as a classificatory character has not been entirely disproved.

TENTATIVE CHARACTER OF THIS CLASSIFICATION.

I have distributed the genera, considered in this paper, among four families, and have five headings for genera that are not referred to families. This classification, which embodies nothing new, except making a family, *Micrabaciidae*, is only an attempt, and should be subjected to the most searching criticism to determine the validity of the characters used in differentiating the families. The *Leptophylliidae*^b

^a Gregory, Jurassic Fauna of Cutch—the Corals, p. 11.

^b The same as Gregory's *Ethinotidae*, which is abandoned, as it was not derived from a genus name.

is very doubtfully separable from Gregory's *Thamnastracidæ*, though they probably should be kept separate. The *Micrabaciidæ* have solid septa and perforate walls. The *Anabraciidæ* are characterized by having a very pronounced and regular trabecular septal structure, but in some genera the basal pores between the trabeculæ are filled with stereoplasm, bringing this family and the *Leptophylliidæ* very close together.

Before the synonymy of the proposed genera can be determined, they must be accurately defined, and here I will repeat *that the generic definitions must be based primarily upon a type species*. After this has been done the study of variation can be undertaken, in order to determine the value of characters supposed to be of generic importance.

The present paper, it is hoped, will aid in the undertaking and carrying out of the studies that must be done before we can understand the Fungid corals.

CLASSIFICATION.

Family FUNGIIDÆ Dana (emend. Duncan).

1846. *Fungidæ* (part) DANA, Zooph. Wilkes Expl. Exped., p. 283.

1849. *Fungiæ* MILNE EDWARDS and HAIME, Comptes rend. Acad. Sci., Paris, XXIX, p. 71.

1884. *Fungidæ* DUNCAN, Jour. Linn. Soc. London, Zool., XXVIII, p. 141.

Diagnosis of the family.—Corallum simple or colonial, depressed or mitroid in form, septa of higher cycles perforate, those of the lower cycles perforate or solid. Synapticula, but no dissepiments, present. Wall usually perforate in young, free individuals; subsequently more or less perforate or compact. No epitheca.

The above diagnosis of the family probably should be supplemented by the following: The embryo becomes attached and forms a trophozooid,^a which gives rise to buds (anthoblasts); these become detached, forming free individuals (anthocyathi). The anthocyathi may remain simple (the genus *Fungia*), or by asexual reproduction become colonial.

The mode of formation of the "anthocyathi" of *Fungia* has been known for many years, Stutchbury first describing it in 1830.^b Bourne has made the mode of reproduction of *Fungia* the subject of very detailed investigations. It has been proven for nearly every known species of the genus that the free disks are produced by buds becoming detached from a parent stock (originally a trophozooid).

J. Stanley Gardiner, in his "Fungid corals" collected in the South Pacific,^c published the extremely interesting observation concerning *Halomitra* (*H. irregularis* Gardiner), that "the free corallum seems, from my specimens (2), to have been formed in a somewhat similar

^a G. C. Bourne, On the Post-embryonic Development of *Fungia*, Sci. Trans. Roy. Dublin Soc., V (2d ser.), 1893, p. 206.

^b Trans. Linn. Soc. London, XVI, 1830, pp. 493-498.

^c Proc. Zool. Soc. London, 1898, pp. 527-528.

manner to that of the genus *Fungia*—by the breaking off of disks from an attached stock. At first there is one large central polyp with radiating septa; then, as growth proceeds, a number of calicular fossae appear around this. On becoming free the central polyp may perhaps persist or, as in my specimens, may become indistinguishable from the daughter polyps, the septa gradually losing their regular radiating arrangement in the center of the colony.”

I have examined specimens of five of the compound genera of the *Fungidae*, hoping to gain more information concerning young stages, and obtained the following results:

Halomitra philippinensis Studer, young. Shows a very distinct scar of detachment.

Zoopilus echinatus Dana. (Probably type specimen.) Shows a very distinct scar of detachment. This genus is scarcely more than a *Halomitra* with very few calices, and these are near the central corallite.

Cryptabacia talpina (Lamarck). There is some suggestion of a detachment scar, but the evidence is not positive.

Herpetolitha limax (Esper) and *H. stricta* Dana. Evidence for detachment scar very vague.^a

Lithactinia galeriformis (Dana) (one of Dana's specimens). Found no evidence of a detachment scar.

Sufficient evidence, of course, is not presented to warrant a conclusion, but there is at least a suggestion that the free coralla of all of these corals may originate in a manner similar to that of *Fungia*.

Genus FUNGIA Lamarck.

1801. *Fungia* LAMARCK, Syst. Anim. sans Vert., p. 369.

Original generic diagnosis.—"Corallum stony, free, orbicular, or hemispherical, or oblong, convex, and lamellate above, with a furrow or depression in the center, concave and rough below.

"A single lamellate, subproliferous star. Lamellæ dentate or spinose laterally."

Type species.—*Fungia agariciformis* Lamarck=*Madr. agaricites* Linnæus.^b Lamarck originally referred six species to the genus, namely:

1. *Fungia agariciformis* LAMARCK=*Madrepora fungites* LINNÆUS.
2. *Fungia scutaria* LAMARCK, based on Seba, Mus., III, pl. cxii, figs. 28, 29, 30.
3. *Fungia limacina* LAMARCK=*Madrepora pileus* ELLIS and SOLANDER, pl. xiv.

^aSince the above was written, I have unpacked a box of Fungid corals from the east coast of Africa, kindly sent to me for determination by Dr. Charles Gravier, of the Muséum d'Histoire Naturelle, Paris. There is a good suite of *Herpetolitha foliosa* Ehrenberg. The young specimens show as distinct a detachment scar as any species of *Fungia*. Therefore the young of *Herpetolitha* is a trophozooid, and the adults are formed by further growth of freed anthoblasts, or anthocyathi.

^bSee Döderlein, Senckenb. Naturforsch. Gesellsch. Abhandl., XXVII, 1902, pp. 136-156, pl. xx-xxv.

4. *Fungia talpina* LAMARCK, based on Seba, Mus., III, pl. CXI, fig. 6, and pl. CXII, fig. 31.
5. *Fungia patellaris* LAMARCK=*Madrepora patella* ELLIS and SOLANDER, pl. XXVIII, figs. 1-4.
6. *Fungia pileus* LAMARCK=*Mitra polonica* RUMPHIUS, Herb. Amb., VI, pl. LXXXVIII, fig. 3.

Lamarck confused in his *Fungia*, corals that are now considered to represent four different genera.

Fungia limacina Lamarck, now = *Herpetolitha limæ* (Esper) Eschscholtz, 1825.

Fungia pileus Lamarck, now = *Halomitra pileus* (Pallas) Dana, 1846.

Fungia talpina Lamarck, now = *Cryptabacia talpina* (Lamarck) Milne Edwards and Haime, 1849.

This leaves in *Fungia* proper, *F. agariciformis* Lamarck (= *fungites* Linnæus), *F. scutaria* Lamarck and *F. patella* (Ellis and Solander).

Leuckart in 1841^a cites *Fungia agariciformis* Lamarck as "Typus," fixing the type.

Milne Edwards and Haime in 1849^b cite under *Fungia*, *F. agariciformis* and *patellaris* Lamarck. In 1850, in their Monograph of the British Fossil Corals,^c *Fungia patellaris* Lamarck is definitely given as the type-species. *F. patellaris* Lamarck (*Madr. patella* Ellis and Solander) can not be the type-species, as *F. agariciformis* Lamarck had already been so designated. In the third volume of the Histoire naturelle des Coralliaires, pages 6, 7, Milne Edwards accepts the latter species as the type, using for it the Linnæan name *Madrepora fungites*.

Remarks.—Prof. Ludwig Döderlein has published an elaborate monograph, Die Korallengattung *Fungia*,^d in which the various skeletal parts of the genus are described in much detail. A bibliography is also given. A discussion of the genus will not be attempted here, as the work of Professor Döderlein can be consulted.

Fungia has several synonyms, which are as follows:^e

CYCLOSERIS Milne Edwards and Haime, Comptes rend. Acad., Paris, XXIX, 1849, p. 72.

The genus was placed by its author in their "*Lophoserinæ*," which was characterized by having "the plateau without epitheca or echinulations, and with imperforate tissues."

Original generic diagnosis.—"Corallum simple, free. Septa very numerous, uniting by their inner margins."

Type species.—*Fungia cyclolites* Lamarck, Hist. nat. Anim. sans

^a Observ. Zoolog. de Zooph. Corall., spec. de Gen. *Fungia*, p. 42, pl. iv, figs. 1-4.

^b Comptes rend. Acad. Paris, XXIX, 1849, p. 72.

^c Introduction, p. xlv.

^d Senckenberg. naturfor. Gesellsch., Abhandl., XVII, Pt. I, 1902, pp. i-iii, 1-162, pls. I-XXV.

^e All of these excepting *Actinoseris* d'Orbigny are discussed by Döderlein, in his Die Korallengattung *Fungia*. For further discussion consult that work.

Vertèbres, II, p. 236; Döderlein, Korallengat. Fungia, pp. 77-79, pl. iv, figs. 7-9, pl. v, figs 5, 5a.

Distribution.—Recent, China Seas and Philippines eastward to the mid-Pacific.

ACTINOSERIS d'Orbigny, Note sur des Polyp. foss., p. 12, 1849.

Original generic diagnosis.—"It is a circular *Cycloseris*, whose columella is central, round, and not in an elongated furrow."

Type species.—*A. cenomanensis* d'Orbigny, Note sur des Polyp. foss., nom. nud.; Prod. de paléontol., II, p. 180; Milne Edwards and Haime, Hist. nat. Corall., III, p. 53.

Distribution.—"Groupe de la craie tuffeau, Le Mans."

Milne Edwards^a refers *Actinoseris cenomanensis* to the genus *Cycloseris*, making d'Orbigny's *Actinoseris* a synonym of their *Cycloseris*. The septal structure of d'Orbigny's genus should be investigated. It may be well to reinvestigate the Tertiary and Cretaceous species of *Cycloseris*, they may not be congeneric with *Fungia* (*Cycloseris*) *cyclo-lites* Lamarck. It is of especial importance to determine whether the free disks of these corals placed in *Cycloseris* originate as *anthocyathi*, as in *Fungia*.

DIASERIS Milne Edwards and Haime, Comptes rend. Acad., Paris, XXIX, 1849, p. 72.

This genus was placed by its authors in their "*Lophoserinæ*," characterized by having "the plateau without epitheca and echinulations, and with imperforate tissues."

Original generic diagnosis.—"Differs from the preceding [*Cycloseris*] in that, when young, it is composed of separate parts that unite later."

Type species.—*Fungia distorta* Michelin, Mag. de Zool., 2d ser., V Année, Zooph., pl. v; Döderlein, Korallengat. Fungia, pp. 74-77, pls. III, v, figs. 3, 3a.

Distribution.—Philippines.

Remarks.—Duncan in his "Revision of the Genera and Families of the Madreporaria"^b places *Ecmesus Philippi*^c and *Hemicyathus Seguenza*^d in the synonymy of *Diaseris*. *Ecmesus* is a doubtful coral, but probably is an imperfect specimen of a Trochocyathoid species. The *Hemicyathus* of Seguenza certainly belongs in that group.

PLEURACTIS Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 52.

Type species.—*Fungia scutaria* Lamarck, Hist. nat. Anim. sans Vert., II, p. 236; Döderlein, Korallengat. Fungia, pp. 91-97, pl. viii, figs. 1-6.

A type species was designated, but no description was published. The genus was intended to embrace more or less elongate, flat, *Fungia*, without tentacular lobes on the septa.

^a Hist. nat. Corall., III, p. 53.

^b Jour. Linn. Soc. London, Zool., XVIII, 1884, p. 150.

^c Neues Jahrb. für Mineral., Jahrg. 1841, p. 665, pl. XI B, figs. 1 a-e.

^d Corallarii fossili del. rocce terz. del dist. Messina, 1864, Pt. 2, p. 67.

LOBACTIS Verrill, Bull. Mus. Comp. Zool., I, 1864, p. 52.

Type species.—*Fungia dentigera* Leuckart, De Zooph. Corall. et spec. Gen. Fungia, pp. 48–49, pl. III, figs. 1, 2, cf. Döderlein, Korallengat. Fungia, pp. 91–97.

There was no original description; only a type species was cited. This group is composed of somewhat elongate, flat species, in which the tentacular lobes of the septa are greatly developed.

CTENACTIS, Bull. Mus. Comp. Zool., I, 1864, p. 51.

Type species.—*Madrepora echinata* Pallas, Elench. Zooph., p. 284; *Fungia echinata*, Döderlein, Korallengat. Fungia, pp. 101–105, pl. x, figs. 1–5.

No diagnosis of the genus was published. It was established for the very large, elongate, *Fungia*, the largest known, in which the septal margins are strongly dentate, the dentations resembling, as the name implies, the teeth of a comb.

HALIGLOSSA (part) Ehrenberg, Akad. Wissensch. Berlin, Abhandl., 1832, p. 274, 1834.

Original generic diagnosis.—[Fungids] compound (polystomatous), base expanded, stoloniferous, extended in two directly opposite directions (its oblong form recalling a tongue = *Manicina liberæ*).

To this genus he refers five species:

1. *Madrepora echinata* Pallas.
2. *Fungia limacina* Lamarck = *Madrepora pileus* Ellis and Solander.
3. *Haliglossa interrupta* Ehrenberg = *Madrepora pileus* of Linnaeus and Pallas = *Fungus pileus oblongus*, Seba, III, pl. CXI, fig. 5.
4. *Haliglossa foliosa* Ehrenberg = *Madrepora pileus* Linnaeus and Pallas, Seba, III, pl. CXI, fig. 3.
5. *Haliglossa stellaris* Ehrenberg = *Madrepora pileus* var. Esper, pl. LXXIII.

No. 1 was considered by Leuckart to be wrongly identified, and was named *Fungia ehrenbergi* by him.^a Professor Döderlein, in his Die Korallengattung *Fungia*,^b places Leuckart *Fungia ehrenbergi* in the synonymy of *Fungia echinata* (Pallas). Milne Edwards and Haime refer the four others^c to the synonymy of *Herpetolitha limax* (Esper) Eschscholtz, 1825.

Therefore the genus *Haliglossa* contained two genera, one part of which belongs to *Fungia* Lamarck, 1801, the other to *Herpetolitha* Eschscholtz, 1825,^d and consequently must lapse.

^a De Zooph. corall. et gen. Fungia, 1841, p. 52, pl. II.

^b Senckenberg. Naturfor. Gesellsch., Abhandl., XXVII, 1902, p. 101.

^c Am. Sci. nat., 3d ser., Zool., XV, p. 94.

^d Eschscholtz's *Herpetolitha* (Isis, XVI, 1825, p. 746), originally contained two species, *Fungia limacina* and *Fungia talpa*, of Lamarck. Milne Edwards and Haime, in 1849 (Comptes Rend., XXIX, p. 71), restricted *Herpetolitha* to the first mentioned species (citing *Madrepora pileus* Ellis and Solander, pl. XLV) and proposed the genus *Cryptabacia* for the second.

Family AGARICIIDÆ Verrill.

1849. *Lophoserina* MILNE EDWARDS and HAIME, Comptes rend. Acad. Sci., Paris, XXIX, p. 72.

1865. *Lophoseridæ* VERRILL, Proc. Essex Inst., IV, p. 146.

1870. *Agaricidæ* VERRILL, Trans. Conn. Acad. Sci., I, p. 542.

1884. *Lophoseridæ* Duncan, Jour. Linn. Soc., Zool., London, XVIII, p. 146.

Diagnosis of family.—Simple or colonial Fungids, with solid septa^a and solid walls. Synapticula present; dissepiments present or absent.

Three genera are placed in this family, *Trochoseris* M. Edwards and Haime, *Palæoseris* Duncan and *Bathyactis* Moseley. *Fungiacyathus*, though probably not a Fungid, is given here, because Moseley thought that it might be closely related to *Bathyactis*.

TABLE OF DIFFERENTIAL CHARACTERS OF THE GENERA.

I. Corallum trochoid or turbinate, pedicellate.

Columella papillary, no epitheca.

1. *Trochoseris* Milne Edwards and Haime.

Columella rudimentary, complete epitheca 2. *Palæoseris* Duncan.

II. Corallum discoid, free, not attached in the young stages.

Columella variable in development, no epitheca.

Septa in deltas, distant, wall thin 3. *Bathyactis* Moseley.

[Columella none, no epitheca.

Septal ends not uniting 4. *Fungiacyathus* Sars].^b

1. Genus TROCHOSERIS Milne Edwards and Haime.

1849. *Trochoseris*, MILNE EDWARDS and HAIME, Comptes rend. Acad., Paris, XXIX, p. 72.

Genus placed by its authors in their "*Lophoserina*," which have the plateau without epitheca and echinulations, and have nonperforate tissues.

Original generic diagnosis.—Simple species, trochoid and fixed.

Type species.—*Anthophyllum distortum* Michelin, Iconog. Zoophytol., p. 149, pl. XLIII, figs. 8a, 8b.

Remarks.—The description published by Milne Edwards and Haime in their Recherches sur les Polypiers^c is practically the same as the one in the Histoire naturelle des Coralliaires.^d The salient characters are well covered in both. The following is the description given in the second work: "The corallum is simple, trochoid or cylindrical and attached. The wall is naked and shows throughout its height fine costal striae. Columella papillary. Septa very numerous and laterally strongly granulate."

^aI think that the young septa in some species of *Agaricia* may occasionally be perforated.

^bThe reason for inserting this genus here will appear under the description of *Bathyactis*. Moseley thought that they might be the same. I do not see how it is possible, and think that *Fungiacyathus* is one of the Turbinolid corals.

^cAnn. Sci. nat., 3d ser., Zool., XV, 1851, p. 118.

^dVol. III, p. 57.

2. Genus PALÆOSERIS Duncan.

1870. *Palæoseris* DUNCAN, Quart. Jour. Geol. Soc., London, XXVI, p. 301.

Genus referred to the *Lophoserinæ*.

Original generic diagnosis.—"The corallum is simple, turbinate, and pedicellate. The septa are numerous. The epitheca is complete and dense, covering the costæ. The columella is rudimentary."

Type species.—*Trochoseris woodsi* Duncan, Ann. and Mag. Nat. Hist., 3d ser., XIV, p. 164, pl. vi, figs. 2a-2c, 1864. Also Quart. Jour. Geol. Soc., London, XXVI, p. 301, pl. xx, figs. 7a, 7b.

Locality and geologic horizon.—Tertiary, Muddy Creek, South Australia.

Remarks.—Duncan does not describe in detail the structure of the septa or the wall. The original figures of *Trochoseris woodsi* indicate that both the septa and the wall are imperforate. Therefore this genus apparently is an epithecate *Trochoseris* with a reduced columella.

Duncan, in his Revision of the Families and Genera of the Madreporaria,^a makes *Palæoseris* a subgenus of *Turbinoseris* Duncan.

3. Genus BATHYACTIS Moseley.

1881. *Bathyactis* MOSELEY, Deep Sea Corals, Challenger Reports, p. 185.

Genus referred to the *Lophoserinæ*.

Original generic diagnosis.—"Corallum free, discoid, not attached or cup-shaped in the young condition, thin and fragile; primary septa free, the others united so as to form six deltoid combinations; upper margins of the septa usually coalescent over the apices of the deltas. Septa deeply toothed; synapticulæ sometimes abundant, sometimes few, arranged in a series of concentric circles. Columella well developed."

Type species.—*Fungia symmetrica* Pourtalès, Mus. Comp. Zool., Ill. Cat., No. IV, p. 46, pl. vii, figs. 5, 6; Moseley, Deep Sea Corals, Challenger Reports, p. 185.

Distribution.—Recent, almost universal in deep water.

Moseley remarks: "I am not sure whether *Fungiacyathus fragilis* of Prof. M. Sars^b will not prove identical with *Bathyactis symmetrica*. If so, the name *Fungiacyathus* will take priority. *Fungiacyathus fragilis* agrees with *Bathyactis symmetrica* in all respects excepting that it has no synapticulæ. In some of the *Challenger* specimens there are very few synapticulæ indeed, but in none are these structures entirely absent. I therefore hesitate to place the two forms together at present. There can be little doubt that they are closely allied, and what little I have seen of the soft parts of *Bathyactis symmetrica* goes to confirm such an opinion."

^a Jour. Linn. Soc. London, Zool., XVII, 1884, p. 148.

^b On some remarkable forms of animal life from the great depths off the Norwegian Coast, I, p. 58, pl. v, figs. 24-32, Christiania, 1872.

4. Genus FUNGIACYATHUS M. Sars.

1872. *Fungiacyathus* M. Sars, Remarkable forms of animal life from great depths off the Norwegian coast, Pt. I, p. 60, pl. v, figs. 24-32.

Original generic diagnosis.—Corallum simple, free, without any sign of attachment, discoid, base horizontal, flat, beneath radially finely costate, no wall (theca) strictly speaking.^a Calice subcircular, upper margin convex (septa tall), crispate. No columella, no pali. Septa numerous, 6 systems, forming 6-8 orders, primaries and secondaries much elevated, arched, transversely finely folded, upper margin faintly undulate, extending to the center, there irregularly lobed and flexed, throughout their length extremely thin, prominent above the outer margin of the calice. Calicular fossa rather large and uniformly depressed.

Type species.—*Fungiacyathus fragilis* M. Sars, Remarkable forms of animal life, etc., p. 58, pl. v, figs. 24-32.

Distribution.—Deep water, off the Norwegian coast.

Remarks.—Moseley (see p. 385) has raised a doubt regarding the systematic affinities of this coral, suggesting that it may be the same as his *Bathyactis*. Judging from the very careful description of G. O. Sars^b I am inclined to believe it a Turbinolid, and not a Fungid.

MICRABACIIDÆ, new family.

Diagnosis of family.—Simple fungids with solid septa and perforate wall.

Five genera are referred to this family: *Micrabacia* Milne Edwards and Haime, *Diafungia* Duncan, *Microsmilia* Koby, *Podoseris* Duncan, and *Antilloseris*, new genus.

TABLE OF DIFFERENTIAL CHARACTERS OF THE GENERA.

I. Costæ corresponding to intercostal spaces:

Corallum circular, lenticular, broader than high.

1. *Micrabacia* Milne Edwards and Haime.

Corallum with triangular piece extending to the center.

2. *Diafungia* Duncan.

II. Costæ corresponding to the septa:

Columella strongly developed, corallum with narrow base, mural pores regular, epitheca thin 3. *Microsmilia* Koby.

Columella small, base variable, mural pores irregular, epitheca present, variable, dissepiments present 4. *Podoseris* Duncan.

Columella, s. s., absent, mural pores irregular, epitheca absent, dissepiments absent 5. *Antilloseris* Vaughan.

^a This must not be taken literally. There is a wall, but it is horizontal.—T. W. V.

^b Remarkable forms of animal life, etc., pp. 58-60.

1. Genus MICRABACIA Milne Edwards and Haime.

1849. *Micrabacia*, MILNE EDWARDS and HAIME, Comptes rend. Acad., Paris, XXIX, p. 7.

Genus placed by Milne Edwards and Haime in their *Funginae*, defined as having "the plateau without epitheca, usually strongly echinulate, tissues perforate."

Original generic diagnosis.—"Septa moderately numerous and straight. Wall scarcely echinulate, costæ alternating with the septa."

Type species.—*Fungia coronula* Goldfuss, Petref. German., I, p. 50, pl. XIV, fig. 10; *Micrabacia coronula*, Milne Edwards, Hist. Nat. Corall., III, p. 29.

Distribution.—Cretaceous, Craie tuffeau, Europe.

Remarks.—Milne Edwards and Haime, in their *Recherches sur les Polypiers*,^a elaborated their characterization of this genus, and Milne Edwards gave additional detail in the third volume of the *Histoire Naturelle des Corallaires* (p. 29). Duncan, in his *Revision of the Families and Genera of the Madreporaria*,^b gives a still fuller description, which I have verified by a study of the type species. It is as follows: "Corallum simple, free, lenticular, broader than high, convex above, slightly concave at the base, which has a circular outline. Calice with a small shallow axial depression, filled by a false columella, from which the principal septa radiate, being joined with those of the higher orders toward the circumference. Septa numerous, solid, imperforate, arched above, with a perpendicular outer edge. Costæ distinct on the base, bifurcating at the edge, a process from two costæ forming a septum. Intercostal spaces continuous with the line of direction of the septa, crossed by synapticala in concentric rows, and perforate between the synapticala. Interseptal loculi crossed by large and small synapticala, which radiate from the base in discontinuous lines, bounding canalicular spaces continuous below with the intercostal openings, and above with the interseptal loculi high up. Costæ granular. Septa crenulate or minutely denticulate."

2. Genus DIAFUNGIA Duncan.

1884. *Diafungia* DUNCAN, Jour. Linn. Soc. London, Zool., XVII, p. 417.

Original generic diagnosis.—"Corallum discoid, free, without trace of adhesion, not quite circular in outline, much broader than high. Base with a triangular piece extending beyond the center, slightly projecting downward, the rest of the coral grouping from its sides and apex, so that there is an appearance of former fracture and subsequent mending. Calice unsymmetrical from the prolongation of the larger septa of the primary piece beyond the center, and from the

^aAnn. Sci. Nat., 3d ser., Zool., XV, 1851, p. 88.

^bJour. Linn. Soc. London, Zool., XVIII, 1884, p. 143.

radiation of septa from the sides and apex of the primary piece to the edge of the disc or the margin.

"Columella absent. Septa numerous, order confused; many join others near to and remote from the margin. Larger septa exsert, arched near the margin, from which they rise perpendicularly, and low near the septa of the primary piece. Septa dentate and strongly granular near their free edge, solid and stout.

"Costae broad, unequal, often bifurcating, variously directed. At the margin each costa gives off a branch on either side to form a septum with the corresponding offshoot of the next costa. Hence the septa correspond with the intercostal spaces. Intercostal spaces regularly furnished with equidistant synaptacula, presenting a regularly perforated appearance. Synaptacula discontinuous, strongly developed between the septa, some reaching high up in the interseptal loculi. There is no true wall, the septa-costal structure being united by synaptacula alone."

Type species.—*Diapungia granulata* Duncan, Jour. Linn. Soc. London, Zool., xvii, pp. 418, 419, pl. xx.

Distribution.—Corean Sea, shallow water, recent.

3. Genus MICROSMILIA Koby.

1888. *Microsmilia* Koby, Schweiz. pakeontol. Gesellsch., Abhandt., XV, p. 414.

Original generic diagnosis.—"Corallum small, simple, cylindrical, conical or discoid, attached by a narrow base. Calice circular or elliptical, superficial or more or less deep. Septa numerous, narrow, dentate on their inner margins, finely granulated on their faces. Columella strong, fasciculate. Wall well developed, membraniform, folded, pierced by equal and equidistant perforations. No dissepiments, but synaptacula are present."

Type species.—*Anthophyllum erguelense* Thurmann, Abram. Gagnebin,^a p. 137, pl. II, fig. 23; Koby, Schweiz. palæontol. Gesellsch., Abhandt., XV, p. 415, pl. cxii, figs. 1-15. M. Koby places three species in his *Microsmilia*, *Anthophyllum erguelense* Thurmann, *Turbinolia delemontana* Thurmann, and *Microsmilia matheyi* Koby, but designates no type species. I have selected the first one, as it is quite elaborately described.

Distribution.—Jurassic, Oxfordian, Switzerland.

Remarks.—In describing *M. erguelense* (Thurmann), Koby gives several other interesting characters. He says that the septa are not perforate, that the wall is covered by a thin epitheca, and both describes and figures quite a number of specimens attached by the base to the inner side of a broken older corallum, reminding one very much of the budding of *Schizocyathus fissilis* Pourtales.^b

^aI have not examined this work. The reference is copied from Koby.

^bMus. Comp. Zool. Cambridge, Ill. Cat., VIII, Mem. IV, 1874, p. 36, pls. vi, figs. 12, 13.

4. Genus *PODOSERIS* Duncan.

1869. *Podoseris* DUNCAN, Mon. Brit. foss. Cor., Sup., Pt. 2, No. 1, p. 25.

Genus placed in the *Lophoserinae*.

Original generic diagnosis.—"The corallum has a large concave base, by which it is attached to foreign bodies. The epitheca begins at the basal margin, and is stout and reaches the calicular margin. The height of the corallum varies. The calice is generally smaller than the base and is convex. The septa are numerous and unequal, the largest reaching a rudimentary columella. The central fossula is circular and small. The costæ are seen when the epitheca is worn; they are distinct, connected by synaptacula, and are straight.

"The genus has been created to admit *Microbacina* with adherent bases and more or less of a peduncle."

Type species.—*Podoseris mammiliformis* Duncan, Mon. Brit. foss. Cor., Sup., Pt. 2, No. 1, p. 25, pl. ix, figs. 2-15; also Ann. and Mag. Nat. Hist., 6th ser., IV, 1889, pp. 28-31, pl. v, fig. 9.

Duncan originally referred two species, *P. mammiliformis* and *P. elongata*, to the genus without designating either one as the type. In his paper On the Cretaceous species of *Podoseris*,^a however, he says, concerning the former: "This species was the type of the genus * * * ." It therefore must be considered the type.

Distribution.—Red Chalk, Hunstanton, England.

Remarks.—Duncan gives in the paper just quoted much more information concerning the structural characters, and publishes the following more detailed diagnosis of the genus:

"The corallum has a narrow or wide base of permanent attachment, the height varies from very low, plano-convex to high; stem more or less cylindrical. Calice more or less circular, with a small axial fossa or projecting there; a columella formed by the septal ends, with or without other structure, small; septa numerous, uniting much, stout, or very slender, solid, largely granular at the free convex edge, minutely acicular at the sides; costæ as continuations of septa, in the direct line, usually the most numerous. Synapticulæ numerous, oblique, continuous with septal nodules, interseptal loculi also with recurved hook-like processes; a delicate arched dissepimental structure scanty. Epitheca exists on the sides and at the periphery.

"*Fossil*: Red Chalk, Oolite, England."^b

Duncan does not make a positive statement concerning the structure of the wall except that in his original diagnosis he says the costæ "are distinct, connected by synapticulæ." Plate ix, fig. 3, of the original figures, shows that the wall is perforate.

^a Ann. and Mag. Nat. Hist., 6th ser., IV, 1889, p. 28.

^b Idem, p. 36.

Tomes^a places Duncan's *Podoseris* in the genus *Rhizangia*, basing his identification on specimens labeled *Rhizangia sedgwicki* Reuss, from the Gosau, sent to him by W. Bölsche. As the type species of *Rhizangia* is the *Astrca brevissima* Deshayes,^b the generic characters must be based primarily upon that species. The *Rhizangia sedgwicki* of Reuss may belong to *Podoseris* Duncan without affecting the validity of Duncan's genus. Tomes makes two observations that deserve consideration, namely, that there is asexual reproduction by gemmation from basal stolons in *Podoseris*, and that dissepiments are present. Tomes's figures (Plate XIV, figs. 7 and 8) do not look as if there was budding from stolons, and Duncan, in his reply to the criticism of Tomes,^c says: "The form is not a social one, and never springs from stolons like *Rhizangia*." Tomes has more recently reiterated his identification of *Podoseris* and *Rhizangia*,^d but has not adduced a particle of evidence to show that they are the same.

I should like to call attention to Felix's opinion on *Rhizangia sedgwicki*. He leaves it in the genus *Rhizangia* in his *Anthozoen der Gosauschichten in den Ostalpen*,^e referring the genus to the *Astrangiaceæ* of M. Edwards and Haime. Most probably the specimens of Tomes are wrongly identified, or he has misinterpreted them.

5. Genus ANTILLOSERIS, new genus.^f

1873. *Turbinoseris* DUNCAN, Quart. Jour. Geol. Soc. London, XXIX, p. 558.

[? *Turbinoseris* Duncan, 1870.]

1884. *Turbinoseris* (part) DUNCAN, Jour. Linn. Soc. London, Zool., XVIII, p. 148.

1899. *Turbinoseris* VAUGHAN, Bull. Mus. Comp. Zool., XXXIV, p. 243.

Generic diagnosis.—Corallum simple, cuneiform, or depressed, may be discoid, base narrow. No epitheca. Wall perforate, synaptulate. Costæ present as the distal terminations of the septa. Septa solid, septal margins dentate (dentations rounded in the type species), septal faces granulate. In cross section the granulations are usually directed inward and hooked. Synapticula out of the thecal ring rare; dissepiments appear to be entirely absent. Columella, strictly speaking, absent. When the more perfect calices are viewed from above, a narrow furrow is seen to occur in the axis; a thin section shows that lower down in the corallum the inner ends of opposed longer septa fuse directly across the axis; lateral fusion of the inner septal ends may, or may not, be complete in the axis.

^a Geol. Mag., new ser. (Dec. III), II, 1885, p. 548.

^b Comptes rend. Acad. Sci., Paris, XXVII, 1848, p. 496.

^c Geog. Mag., new ser. (Dec. III), III, 1886, pp. 53, 54.

^d Idem (Dec. IV), VI, 1899, p. 306.

^e Palæontographica, XLIX, 1903, p. 268.

^f Illustrations will be published in my forthcoming Tertiary Corals of North America, Part II, U. S. Geol. Surv. Mon., vol. —. (In preparation.)

Type species.—*Turbinoseris cocænica* Duncan, Quart. Jour. Geol. Soc. London, XXIX, p. 558, pl. XXI, fig. 12, 12a–12c.

Distribution.—Older Tertiaries of the Antilles.

Remarks.—Duncan referred the corals for which I am proposing *Antilloseris* to his *Turbinoseris*,^a but it seems probable that *Turbinoseris* is a synonym of *Leptophyllia* Reuss. As will be pointed out later, *Turbinoseris* has never been properly defined (see p. 410). Rather than leave the West Indies species in the uncertain state in which they have been for many years, I have erected a new genus for them.

Antilloseris is very closely related to *Podoseris* Duncan. The former differ from the latter (1) by being devoid of epitheca, (2) by the absence of dissepiments, (3) by the absence of a columella. *Podoseris* appears to possess a small, but papillate columella.

Family LEPTOPHYLLIIDÆ, new name.

1900. *Elmotidæ* GREGORY, Jurassic Fauna of Cutch—The Corals, p. 30. (Synonymy given by Gregory on p. 161.)

Diagnosis of the family.—Simple or colonial Fungids, in which the septa are perforate lamellæ; perforations exist principally near the top or the inner ends of the septa, the pores below filled with stereoplasm.

I have placed nine of the described genera in this family, namely: *Gyroseris* Reuss, *Leptophyllia* Reuss, *Haplaræa* Milaschewitz, *Protethmos* Gregory, *Metethmos* Gregory, *Frechia* Gregory, *Placoseris* de Fromentel, *Lithoseris* Koby and *Procycololites* Frech. I have appended under the heading “Septa as in *Leptophylliidæ*; condition of wall unknown,” *Myriophyllia* Volz, *Omphalophyllia* Laube and *Craspedophyllia*, subgenus, Volz.

I think it very probable that the number of these genera will be considerably reduced.

TABLE OF DIFFERENTIAL CHARACTERS OF THE GENERA.

Wall solid:

I. No columella, thick epitheca..... 1. *Gyroseris* Reuss.

Wall perforate:

II. Columella absent or rudimen- tary.....	Epitheca incom- plete or thin.	Septa perforate above, solid below, calice superficial.....	2. <i>Leptophyllia</i> Reuss.
		Septa perforate above, solid below, calice deep.....	3. <i>Procycololites</i> Frech.
		Septa with large irreg- ular pores, fusing with synapticula to form an irregular mesh-work	4. <i>Haplaræa</i> Milasche- witz.

^aFor a discussion, see p. 410 of this paper.

III. Columella	spongy, parietal }	Epitheca absent or rudimen- tary	Septa perforate near axis and top	5. <i>Protethmos</i> Gregory. ^a
			Septa largely perfo- rate; no dissepi- ments .....		6. Frechia Gregory.
IV. Columella	spongy, promi- nent }	Epitheca com- plete	Dissepiments highly developed	7. <i>Physoseris</i> Vaughan. ^b
			Septa little compact (“peu compactes”)		8. Lithoseris Koby.
V. Columella	spongy, papillary.)	Epitheca absent or rudimen- tary	Septa perforate near axis and near sur- face, solid below...	9. <i>Metethmos</i> Gregory.
VI. Columella	composed of com- pressed fused tra- becula...	Epitheca appar- ently absent..	Septa apparently per- forate along upper edge	10. <i>Plucoseris</i> de Fro- mentel.

1. Genus GYROSERIS Reuss.

1854. *Gyroseris* REUSS, Denkschrift. Akad. Wiss. Wien, Mat. Naturhist. Cl., VII, p. 126.

Genus referred to the *Lophoserinae* of Milne Edwards and Haime.

Original generic diagnosis.—“Corallum free, simple, discoid or low-conical. Septa numerous, united by synaptacula. Papillary columella. Wall low, conical, with thick, concentrically wavy epitheca.”

Type species.—*Gyroseris patellaris* Reuss, Denkschr. Akad. Wiss. Wien, Mat. Naturhist. Cl., VII, p. 126, pl. VII, figs. 12-15.

Remarks.—By neither Milne Edwards and Haime nor Duncan is anything additional given regarding this genus. Felix, however, in his *Anthozoen der Gosausehichten in den Ostalpen*,^c says: “I should like to remark in addition to the description of Reuss that a columella either is absent or remains rudimentary. Isolated dissepiments, as well as synaptacula, occur between the septa. The septa originally are porous (‘werden pöros angelegt’), but appear to become compact.”

This genus appears very closely related to *Leptophyllia*. If the wall should be perforate the only means of differentiation is the thick, concentrically wavy epitheca, a character of doubtful diagnostic value.

^a It is possible that the wall of this genus is solid. In that case it would belong near *Gyroseris*.

^b This genus may have a papillary columella.

^c *Paleontographica*, XLIX, 1903, p. 226.

2. Genus *LEPTOPHYLLIA* Reuss.

1854. *Leptophyllia* REUSS, Denkschr. Akad. Wiss. Wien, Mat. Naturhist. Cl., VII, p. 101.

Original generic diagnosis.—"Corallum simple, more or less conical or turbinate, attached by the base. No columella. Very numerous, crowded, thin septa that fuse directly in the center, upper free margins furnished with very distinct, regular, pointed, short teeth. The outer wall without epitheca, ribs distinct and covered with strong, pointed, grain-like teeth.

"Is separated from the very nearly related genus *Montlivaltia* by the absence of epitheca, from *Trochosmilia* by the dentation of the free margins of the septa."

Type species.—*Leptophyllia clavata* Reuss, Denkschr. Akad. Wiss. Wien, Mat. Naturhist. Cl., VII, p. 101, pl. VI, figs. 3-6.

Distribution.—Cretaceous, Senonian, Gosau, Austria.

Pratz, in his Ueber die verwandtschaftlichen Beziehungen einiger Korallengattungen mit hauptsächlichlicher Berücksichtigung ihrer Septalstruktur,^a made a careful study of the septal structure of *Leptophyllia clavata*, and showed that the septa of that species are composed of trabeculae which stand more or less perpendicular to the septal margin. The trabeculae consist of rows of nodules (Knötchen), which are regularly grouped, quite often spirally, as in *Cyclolites*. The lateral granulations of neighboring trabeculae often fuse and form vertical rows of pores. In the bottom of the calice the pores are filled, the rows of pores are mostly seen on the upper part of the septum, while on the lower part they usually disappear. The wall is described as dissepimental.^b

Ogilvie, in her Korallen der Stramberger Schichten,^c redefined the genus and followed the data of Pratz in drawing up her definition. Felix, in his Anthozoen der Gosauschichten in den Ostalpen,^d merely refers to Pratz's work for an account of the microstructure of the genus. He combines the *Leptophyllia irregularis* and *L. clavata* Reuss, thus making the genus monotypic. Several other forms not originally referred to *Leptophyllia* are also placed in the synonymy of *L. clavata*.

^a Palæontographica, XXIX, 1882, pp. 90-92.

^b Gregory, in his Jurassic Corals of Cutch, p. 162, makes a statement that is difficult to understand. In discussing the affinities of his *Ethmotidae*, he says: "They form the chief part of the alliance *Leptophyllioida* of Duncan. But uncertainty as to the structure of true *Leptophyllia* of Reuss renders it inadvisable to take that genus as the type of the group." I do not see how the description of Pratz, based on one of Reuss's original species, could have been overlooked. There is scarcely any coral whose septal structure is more thoroughly known than that of *Leptophyllia*.

^c Palæontographica, Sup. II, VII Abtheil., 1897, p. 218.

^d Idem, XLIX, 1903, pp. 200-202.

The following is Ogilvie's recharacterization of *Leptophyllia*:^a

"Corallum simple, conical, or cylindro-conical, with superficial calice. Septa numerous, thin, margins regularly toothed, on the faces rows of granulations that run perpendicular to the septal margin and form pseudo-synapticula. Septa not always, and then only partially, perforate. Dissepiments thin, numerous, vesicular, thicker toward the periphery and with the septa forming a pseudotheca. Costal ends of the septa finely toothed. Thin epitheca present."

As full a discussion of the relations of *Leptophyllia* and *Turbinoseris* as is at present possible is given on pp. 410-412.

3. Genus PROCYCLOLITES Frech.

1890. *Procycolites* FRECH, *Palæontographica*, XXXVII, p. 64.

Original generic diagnosis.—"Simple, more rarely composed of two fused individuals. Calice deep. Inner structure partly similar to *Cyclolites*. However, the septa rather quickly become solid lamellæ, the number of pores that remain open is small and they are confined to the youngest parts of the septa (fig. 11 A). On the faces of the septa are horizontal, elongate dissepiments, but they almost never unite with those of the neighboring septa. True synapticula are rare. Dissepiments fine and numerous."

Type species.—*Procycolites triadicus* Frech, *Palæontographica*, XXXVII, p. 64, pl. xviii (all figs. except 17), text fig., p. 65.

Distribution.—Triassic, Fischerwiese, Gosau, etc., Austria.

Remarks.—Frech says that "The external differences (the deep calice) are scarcely sufficient to separate the genus from *Cyclolites*, especially as *Cyclolites undulata* possesses much external resemblance. However, the presence of synapticula alongside of dissepiments, also the relative rarity of septal pores, constitute sufficient differences. *Procycolites* probably represents, as its name indicates, a predecessor of *Cyclolites*. There is no nearer relationship to *Haplaræa* Milaschewitz (Upper Jurassic) (with which *Diplaræa* belongs), as the septa of the Jurassic corals are distinctly porous. The septal structure of *Leptophyllia*^b shows only a remote resemblance. In it the septal spines originate separately, and are covered with numerous, regularly arranged nodules."

Frech published no observation on the wall, columella, or epitheca. However, information on these structures can be obtained from his figures. The distal ends of the septa are represented as free—they probably are united by synapticula. Fig. 7 represents a specimen, "wohlerhaltene Aussenseite mit Theka." Apparently there is an incomplete epitheca. Fig. 5, a section across the axis of a specimen, shows no vestige of a columella, nor does fig. 4 show any.

^a *Palæontographica*, Sup. II, VII Abtheil., 1897, p. 218.

^b *Idem*, XXIX, pl. xiv, fig. 9.

4. Genus *HAPLARÆA* Milaschewitz.

1876. *Haplaræa* MILASCHEWITZ, *Palæontographica*, XXI, p. 228.

Original generic diagnosis.—"Corallum simple, cylindrical, attached to the object of support by a broad surface, outside covered by a smooth, wavy epitheca. The septa are rather strongly developed, with large pores scattered without order. The younger septa unite with the older, and all the septa are united by numerous and well-developed synaptacula. Columella absent."

Type species.—*Haplaræa elegans* Milaschewitz, *Palæontographica*, XXI, p. 229, pl. LI, figs. 2, 2a, 2b.

Distribution.—Jurassic, Nattheimer Schichten, Germany.

Remarks.—Pratz^a describes a coral, that he refers to *Haplaræa*, from the Cretaceous of St. Gilgen, on Wolfgangsee. Unfortunately this coral can not be used in defining the genus *Haplaræa*.

Ogilvie in her *Korallen der Stramberger Schichten*, pages 250, 251, apparently bases her remarks on *Haplaræa* on the work of Pratz, a procedure that is unfortunate, but her redefinition of the genus (p. 261) does not differ specially from the original definition of Milaschewitz.

Ogilvie's redefinition.—"Corallum simple, cylindrical. Septa numerous, very perforate, irregularly curved, and abundantly fusing by their sides. Septa often resolved into short, thick trabeculæ, and forming with the synaptacula an irregular, perforate mess work. Pseudosynaptacula not numerous. Dissepiments numerous and vesicular. Columella not recognizable. No true wall present, only a pseudothecal thickening of the septal and interseptal skeletal parts near the outer wall. Epitheca thin, wrinkled, reaching to the calicular margin."

Milaschewitz referred *Haplaræa* to the *Poritidæ*; Zittel^b placed it with *Calostylis* in the *Eupsammidæ*. Ogilvie followed Zittel. Gregory^c places it in his *Ethmotidæ*.

5. Genus *PROTETHMOS* Gregory.^d

1900. *Protethmos*, GREGORY, *Jurassic Fauna of Cutch, The Corals*, p. 162.

Original generic diagnosis.—"Ethmotidæ in which the corallum is simple and short; conical, turbinate, or pedunculate. Septa perforate near the axis and near the top; granulate laterally, and coarsely denticulate above; rather stout, numerous, and usually straight. Synapticulæ, scarce. Columella, parietal, spongy; well developed. Calice shallow or of medium depth."

Type species.—*Protethmos oldhami* Gregory, *Jurassic Fauna of Cutch, The Corals*, p. 164, pl. XVIII, figs. 10-13.

^a Verwandtschaftliche Beziehungen einiger Korallengattungen, pp. 102, 103.

^b Handb. Palaontologie, I, 1880, p. 242.

^c Jurassic Corals of Cutch, p. 162.

^d If the wall of this genus is imperforate it should be placed near *Gyrosesis*.

Distribution.—Jurassic of India.

Remarks.—Gregory gives a lengthy discussion of the affinities of *Protethmos*.^a It is separated from *Epistreptophyllum* Milaschewitz, *Lithoseris* Koby (probably a synonym of the former) and *Turbinoseris* Duncan by these genera probably having imperforate septa. I have pointed out in the present paper that none of them is adequately described. *Podoseris* Duncan is said positively to have imperforate septa.

Gregory does not describe the wall, nor does he state whether epitheca is present or absent. Figs. 10c and 12c (Plate XVIII) show a thick, imperforate wall—such is at least the condition below the upper edge of the calice. Epitheca appears from the figures to be absent or only vestigial.

6. Genus FRECHIA Gregory.

1900. *Frechia* GREGORY, Jurassic Fauna of Cutch, The Corals, p. 167.

Original generic diagnosis.—" *Ethmotidæ*, with a small, simple corallum, which is free or pedunculate, trochoid, or cylindrical. Calice variable in depth; generally fairly deep. Septa largely perforate; synapticulae scarce; no dissepiments. Columella parietal, but well-developed."

Type species.—*Frechia cornutiformis* Gregory, Jurassic Fauna of Cutch, p. 168, pl. xxi, figs. 1-3.

Remarks.—This genus is separated from *Protethmos* Gregory by its more abundantly perforated septa, and from *Leptophyllia* Reuss by its possessing a well-developed parietal columella.

Gregory in his generic diagnosis gives no information on the character of the wall, nor as to the presence or absence of dissepiments and epitheca. However, in the description of the type species, *F. cornutiformis*, he says, "near the margin of the coral the septa may be united by secondary thickening into an apparent wall." This would indicate an abundantly perforate wall. Judging from Plate XXI, fig. 3b, near the base the septa are distally much thickened, forming a thick pseudotheca. Plate XXI, fig. 2, apparently shows dissepiments alongside synapticulae. If epitheca is present, it is only vestigial.

7. PHYSOSERIS, new genus.^b

1873. *Trochosmilia* DUNCAN, Quart. Jour. Geol. Soc., London, XXIX, p. 552, pl. XIX, figs. 2, 2a, 3, (not *Trochosmilia* Milne Edwards and Haime).

Generic diagnosis.—Corallum simple, subcylindrical or compressed. Epitheca entirely absent or rudimentary. Wall composed of pseudothecal thickenings of the septa, or of dissepiments; it is mostly dissepimental.

^aJurassic Fauna of Cutch, The Corals, p. 163.

^bIllustrations will be published in my forthcoming Tertiary corals of North America. Part II. U. S. Geol. Surv., Mon., vol. —. [In preparation.]

mental. In fact, the dissepiments are so arranged as to give the appearance of an imperforate wall in many, if not most, cases. Costae present, representing the peripheral ends of the septa; rather prominent and distant, often with definite girdling exothecal rings, the dissepiments in these rings extending to the costal ends. Between the rings thinner dissepiments can often be seen. Septa irregularly perforate, the first and second cycles thicker and not so perforate as the higher cycles, however they show distinct perforations; in three polished sections I found about three thicker septa that seemed to be imperforate. The septa of the higher cycles are thinner and more perforate. There is no regularity in the perforations—they may exist near the columella, in the median portion of a septum, or near the peripheral (costal) end. A longitudinal section shows that the trabeculae may be interrupted. The septal pores do not fill up near the base, probably due to the highly developed dissepiments cutting off the base of the corallum from the soft parts of the polyp. There is a tendency, but not a very striking one, to form septal groups. Synapticulae scarce, present near the base, and probably also near the inner ends of the septa. Dissepiments well developed, curving outward, one set above another. In a cross section of a corallum they show as several definite rings—usually three or four rings occur between the columella and the peripheral or mural zone. Columella distinctly developed, shows in transverse section as a number of axial trabeculae, which may be more or less fused among one another, and to the inner ends of the septa. Its upper surface is probably, though not positively, papillate.

Type species.—*Trochosmilium insignis* Duncan (= *T. insignis* Duncan + *T. arguta* Duncan (not Reuss)), Quart. Jour. Geol. Soc. London, XXIX, p. 552, pl. XIX, figs. 2, 2a; also fig. 3.

Distribution.—Old Tertiaries of St. Bartholomew, West Indies.

Remarks.—How Duncan ever referred his *Trochosmilium insignis* to *Trochosmilium* passes comprehension. As Prof. A. G. Högbom, of the University of Upsala, has kindly loaned me Duncan's type, I have been able to base a large portion of the above description on the type specimen. Two thin sections, two polished transverse sections, and one polished longitudinal section of other specimens were prepared. Duncan's type (which had been cut) shows nearly every character, given in the preceding diagnosis, that can be seen on a transverse section. His figure of the transverse section (Plate XIX, fig. 2a) clearly indicates perforate septa. The specimen identified by Duncan as *T. arguta* Reuss is precisely the same thing. It also has perfectly distinct septal perforations, and there are hints of columellar papillae.

This genus, I think, is most closely related to *Frechia* Gregory, but can be immediately separated by its highly developed dissepiments. The genus seems to be unusually distinct from any of those previously described.

8. Genus LITHOSERIS Koby.

1886. *Lithoseris* Koby, Schweiz. Palaeontol. Gesellsch., Abhand., XIII, p. 338.

Original generic diagnosis.—"Corallum simple, more or less elevated and turbinate. Septa numerous, crowded, little compact (*peu compactes*), free margin divided into irregular granulations, septal faces covered with irregular granulations. Columella spongy, prominent. Epitheca complete. Pseudo-synapticula numerous. Dissepiments rare."

Type species.—*Lithoseris gracilis* Koby, Schweiz. Palaeontol. Gesellsch., Abhand., XIII, p. 338, pl. xciii, figs. 32, 32a. M. Koby in establishing this genus placed two species in it, *L. gracilis* and *L. compressa*, both named by himself. He did not designate a type species. I have therefore arbitrarily selected the first.

Distribution.—Jurassic, St. Ursanne, Switzerland.

Remarks.—M. Koby does not take up this genus in his *Remarques paléontologiques sur les Polypiers jurassiques de la Suisse*.^a The structure of the wall and septa is not adequately discussed. However, from his placing it near *Leptophyllia*, one may be justified in thinking that it differs from that genus by possessing a complete epitheca and a well-developed, prominent columella.

Ogilvie, in her *Korallen der Strambergerschichten*,^b places *Lithoseris* in the synonymy of *Epistreptophyllum* Milaschewitz.

The Nattheim specimens of *Epistreptophyllum* have not, I believe, been sufficiently studied for us to know positively the characters of that genus. *Lithoseris* also needs further study. However, I will say that an examination of the plates of Milaschewitz and Koby furnishes support to Ogilvie's view, but her conclusion can not be accepted as proven. Gregory^c makes observations on the relations of *Lithoseris* and *Epistreptophyllum* of practically the same import as what is said above.

9. Genus METETHMOS Gregory.

1900. *Metethmos* GREGORY, Jurassic Fauna of Cutch, the Corals, p. 165.

Original generic diagnosis.—"Ethmotidae in which the corallum is simple, short, conical, and pedunculate. Calice shallow. Septa perforate near the axis and near the surface, but near the base the pores are closed by stereoplasm. Septa fairly straight and crowded. Dentate. Synapticulae scarce. Columella well developed, papillary."

Type species.—*Metethmos blanfordi* Gregory, Jurassic Fauna of Cutch, p. 165, pl. xviii, figs 4-6, 8, 11.

^a Schweiz. Palaeontol. Gesellsch., Abhand., XVI.

^b Palaeontogr., Sup., II, p. 255.

^c Jurassic Fauna of Cutch, the Corals, p. 163.

Remarks.—Gregory says *Metethmos* is most closely allied to *Pro-tethmos*, differing from that genus by possessing a well-developed papillary, instead of a parietal columella. *Microsmilia* Koby differs in having a regularly perforate wall.

The structure of the wall is not given, nor is anything said concerning the epitheca. Fig. 6*b* (Plate XVIII) indicates that below the bottom of the calice the wall is compact; fig. 8*b* seems to show a few perforations. Epitheca, if not altogether absent, is only vestigial.

10. Genus PLACOSERIS de Fromentel.

1860. *Placoseris* de FROMENTEL, Paléontol. franç., Crétacé, VIII, Pt. 24, p. 329.

Original generic diagnosis.—"Corallum attached by a wide base, wall cylindrical. Costæ granulated and well marked. Septa synap-ticulate, numerous and unequal, columella elongate, composed of a series of trabeculæ fused together and laterally strongly spinose."

Type species.—*Placoseris patella* de Fromentel, Paléontol. franç., Crétacé, VIII, p. 330, pl. XLIX, fig. 4.

Distribution.—Cretaceous, Cenomanian, Saint Croix, France.

Remarks.—M. de Fromentel says nothing about the structure of the wall or septa, nor does he make any statement regarding the epitheca. According to his enlarged figure of the calice (Plate XLIX, fig. 4*b*), the wall appears perforate in places; the septa seem to be interrupted along the upper margins, strongly suggesting pores. Epitheca is not indicated in the upright view of the corallum, fig. 4. However, the type species needs to be carefully restudied.

SEPTA AS IN LEPTOPHYLLIIDÆ; CHARACTER OF WALL UNKNOWN.

Myriophyllia Volz.

Omphalophyllia Laube.

Subgenus *Craspedophyllia* Volz.

Genus MYRIOPHYLLIA Volz.

1896. *Myriophyllia* Volz, Palæontographica, XLIII, p. 64.

Original generic diagnosis.—"Corallum simple, with numerous instances of transitions to compound or compact mode of growth. The septa are extremely fine and numerous. They are composed of distinctly differentiated trabeculæ (Balken), are mostly compact, but pores may be present. Especially characteristic are the long, jagged, macroscopically scarcely visible septal granulations, with which the septal faces are covered. Columella spongy. Synapticula numerous. Endotheca, and usually also the pseudotheca, well developed. Central fossa round or elongate, sunken."

Type species.—*Myriophyllia badiotica* Volz, *Palaeontographica*, XLIII, p. 75, pl. ix, fig. 9, text figs., pp. 74, 75.^a

Volz places five species in *Myriophyllia*, namely: *Myriophyllia badiotica* Volz, new species, *Omphalophyllia gracilis* Laube (= *O. gracilis* + *O. cyclotiliformis* Laube), *Myriophyllia münsteri*, new species, *Montlivaltia dichotoma* Klipstein and *Myriophyllia mojsvari*, new species, without designating a type species.

Distribution.—Trias, Schichten von St. Cassian, South Tyrol.

Remarks.—According to Volz,^b the *Omphalophyllia* of Laube contained two genera, both very closely related, but distinguishable through differences in their columellae. Some of the species originally placed in *Omphalophyllia* by Laube possess a compact columella; these Volz retains in *Omphalophyllia*. Others possess a spongy and often very scant (*sehr spärlich entwickelt*) columella; for these he proposed the name *Myriophyllia*.

Volz does not describe the wall under the generic diagnosis, nor does he make any remarks on the epitheca. Under the description of the type species *M. badiotica*, however, he says: "The wall is very thin, not thickened by stereoplasmic deposit. Externally it appears solid. It is beset with coarse, often strongly projecting collarlike processes, between which are fine wrinkles. The septa are visible externally as longitudinal ribs." Therefore, apparently the wall is imperforate, and there is no epitheca.

Genus OMPHALOPHYLLIA Laube.

1865. *Omphalophyllia* LAUBE, *Denkschr. Akad. Wissensch. Wien, Mat. Naturhist. Cl.*, XXIV, p. 251.

Original generic diagnosis: "Corallum simple, attached; epitheca strong; columella prominent, styliform; septa numerous, slightly unequal, dichotomous, curved, granulated, serrate; calice, subplane." (Translation of Latin diagnosis.)

"Corallum simple, attached, sometimes pedicellate; the columella distinctly developed, styliform, forming a buttonlike projection in the bottom of the calice. Septa numerous, slightly arched, serrate on the sides, granulate on the upper margin [*sic*, auf den Seiten gesagt, auf dem obern Rande gekörnt!],^c straight or curved, anastomosing and radiating dichotomously or trichotomously from the calicular fossa. Epitheca strongly developed, always present, reaching to the

^aThis is the same as the *Montlivaltia*? new species Loretz, *Zeitschr. deutsch. geolog. Gesellsch.* 1875, p. 825, pl. xxii, fig. 9; the label of the original specimen bearing, according to Volz, the name *Montlivaltia badiotica* Loretz. Apparently Loretz never published the name, therefore the species must be credited to Volz.

^b*Palaeontographica*, XLIII, p. 63.

^cI think Laube must have meant *auf dem obern Rande gesagt, auf den Seiten gekörnt*, i. e., by a printer's error the words "*Seiten*" and "*Rande*" have been transposed.

margin of the calice. Calice shallow, discoid." (Translation of German diagnosis.)

Type species: Omphalophyllia boletiformis (Münster) = *Montlivaltia boletiformis* Münster (Beitr. Geognos. und Petref. südöst. Tirols, Pl. II, fig. 9)^a = *Omphalophyllia gracilis*, c. p. Laube. (Synonymy after Volz.)

Laube cites,^b *Omphalophyllia gracilis* Münster as the type. Volz, in his Korallen der Schichten von St. Cassian,^c says that Laube confused three different species under the name *Omphalophyllia gracilis*. Laube gives, on Plate III of his work cited, three figures, 5, 5a, and 5b. In the explanation of the figures, he says: "Fig. 5. *Omphalophyllia gracilis* Münster from the side, *a* from above, *b* very much enlarged cross section of a calice, diagrammatic." According to Volz:

"(1) Fig. 5 = *Omphalophyllia boletiformis* Münster not Laube.

"(2) Fig. 5a = *Craspedophyllia gracilis* Laube.

"(3) Fig. 5b = *Myriophyllia gracilis* Laube. (The septa are represented as black. There is no columella.)"

From a study of Laube's figures I believe that figs. 5 and 5a are two views of the same specimen and that the "black" in fig. 5b can not represent the septa. If such were the case there would be no wall, no columella, and the septa would be as perforate as in *Anabrachia*. It is my opinion that Laube's figures all represent the same species. The type-species of the genus is represented by Plate III, figs. 5, 5a, 5b, or, if Volz's contention is true, by fig. 5.

Distribution.—Triassic, St. Cassian beds, southern Tyrol.

Remarks.—Volz, in his Korallen der Schichten von St. Cassian (p. 64), undertook to redefine *Omphalophyllia*. He, however, makes no reference to a type-species. His diagnosis is as follows: "*Thamnas-tracidae* of simple (fungioid, discoid, conical, or cylindrical form) or compound growth. The septa are composed of distinctly differentiated trabeculae; pores are rare. On the septal faces are more or less distinctly horizontal rows of granulations, sometimes also compact dissepiments. The columella firm and compact; more rarely are small holes recognized in its structure. Synapticula present." Although Volz does not say it, his description applies to his *O. boletiformis* (Münster), Plate VIII, figs. 1-8.

The wall is not satisfactorily described. Under *O. boletiformis* he says: "The wall is very thin; when preserved it appears externally to be solid. Covered with numerous weak transverse wrinkles." One is led to suspect that only the epitheca is described.

^aThis reference is taken from Volz. I have not been able to consult Münster's work.

^bDenkschr. Akad. Wis. Wien., Math. Naturhist. Cl., XXIV, p. 251.

^cPaleontographica, XLIII, p. 66.

Genus OMPHALOPHYLLIA Laube.

Subgenus CRASPEDOPHYLLIA Volz.

1896. *Craspedophyllia* Volz, *Palaeontographica*, XLIII, p. 64.

Generic diagnosis.—"The new subgenus *Craspedophyllia* is separated from *Omphalophyllia* by possessing a primitive septum (*Urseptum*) and horizontal endothecal dissepiments."

Type-species.—*Craspedophyllia cristata* Volz, *Palaeontographica*, XLIII, p. 65, pl. VII, figs. 10-14, 22, text fig. 15, p. 15.

Volz referred three species to this subgenus, namely: *Axosmilia alpina* Loretz, *Craspedophyllia cristata*, new species, and *Omphalophyllia gracilis* Laube, designating no type-species. As Volz lays so much stress on the "*Urseptum*," I have selected as the genotype the species for which the "*Urseptum*" is figured (p. 15, fig. 15). However, the horizontal dissepiments appear to be more typically developed in *Craspedophyllia gracilis* (Laube) Volz.

Distribution.—Triassic, St. Cassian beds, south Tyrol.

Family ANABRACIIDÆ Duncan (spelling emend.).

1884. *Anabraciidae* DUNCAN, *Jour. Linn. Soc. London, Zool.*, XVIII, p. 165.

1900. *Microsolenidae* GREGORY, *Jurassic Fauna of Cutch, the Corals*, p. 30 (synonymy, p. 173).

Original diagnosis of family.—"Madreporaria Fungida simple or colonial. Septa trabeculate and fenestrated. Synapticula small. Dissepiments absent. Wall indistinct."

The family must be extended to include genera in which dissepiments exist.

Gregory's *Microsolenidae*^a becomes an exact synonym. His definition is "Simple or colonial Fungida in which the septa are palissades of more or less vertical, disconnected, regular, or irregular trabeculae."

Four genera, *Anabracia* d'Orbigny, *Trochophlegma* Gregory, *Cyclolites* Lamarek, and *Trocharæa* Étallon are placed in this family.

TABLE OF DIFFERENTIAL CHARACTERS OF THE GENERA.

I. Columella—none	No epitheca...	Septa very thin, trabeculae mostly separate, fusing very little.	1. <i>Anabracia</i> d'Orbigny.
		Septa externally subequal, trabeculae somewhat fused below.	2. <i>Trochophlegma</i> Gregory.
	With epitheca.	Septa externally some larger.	3. <i>Cyclolites</i> Lamarek.
II. Columella—parietal.	No epitheca	Septal trabeculae united below into short series.	4. <i>Trocharæa</i> Étallon.

^aJurassic Fauna of Cutch, the Corals, 1900, p. 30.

1. Genus ANABRACIA d'Orbigny.

1849. *Anabracia* d'ORBIGNY, Notes sur des Polyp. foss., p. 11.

Original generic diagnosis.—"Form circular, depressed, convex, and covered above with small radiating, unequal septa; base horizontal, with radiating, granulated, dichotomous ribs."

Type-species.—*A. bajociana* d'Orbigny = *Fungia complanata* De-france, 1820, Dict. Sci. Nat., XVII, p. 217.

Distribution.—Inferior Oolite of Europe.

Remarks.—Milne Edwards in 1860^a changed the spelling of the name from *Anabracia* to *Anabacia*, redefined the genus in much greater detail, and placed d'Orbigny's *A. bajociana* in the synonymy of the *Fungia complanata* of De-france.^b This characterization holds good for to-day and is as follows: "The corallum is simple, free, and without trace of adhesion; it has the form of a small plano-convex lens. The upper surface shows in the center a small, shallow fossa, where no trace of a columella can be distinguished. The septa are subtrabecular (*subpoutrelles*), very numerous and thin, finely and regularly crenulate; they terminate on the lower face of the corallum in crenulate costal edges similar to those of the upper surface, without there being a distinct basal wall. The septa of the last cycle unite by their inner margins to the neighboring primaries.

"The *Anabaciæ* differ from the other species of this subfamily [*Funginæ*], the *Fungiæ* and *Micrabaciæ*, by the absence of a wall, properly speaking, and the much less perfectly developed septa."

The septa of *Anabracia* are formed by palissades of small rods (trabeculæ) connected with one another so as to form a regularly fenestrated network. Duncan makes the genus the type of his family *Anabaciadæ*.^c Gregory places it in his *Microsolenidæ*.^d

2. Genus TROCHOPHLEGMA Gregory.

1900. *Trochophlegma* GREGORY, Jurassic Fauna of Cutch, the Corals, p. 179.

Original generic diagnosis.—"Microsolenidæ, in which the corallum is simple or composed of a few corallites united by lateral gemmation; it is fixed or free, and may be pedunculate or have a rounded convex base. Calice small, but well marked. Columella absent; the calicular fossa is small, but rather deep; it is central or excentric in position. Septa very numerous; trabicular. The septal elements consist of upright rods, which slope slightly outward as they are followed from the base; they are connected by two sets of cross rods at right angles to each other. The concentric horizontal bars are very conspicuous

^a Hist. nat. Corall., III, pp. 31, 32.

^b Dict. Sci. nat., XVII, 1820, p. 217.

^c Jour. Linn. Soc. London, Zool., XVII, 1884, p. 165.

^d Jurassic Fauna of Cutch, the Corals, 1900, p. 174.

in vertical sections. The rods are often connected by stereoplastic deposits, which give rise to an appearance of continuous plates in transverse sections (Plate XXIII, figs. 9c and 9d)."

Type species.—*Trochophlegma tenuilamellosa* Gregory, Jurassic Fauna of Cutch, p. 180, pl. XXIII, figs. 3–10.

Distribution.—Jurassic, Upper Putehum beds, Kach, India.

Remarks.—Gregory says: "*Trochophlegma* is nearer to *Cyclolites* [than to *Leptophyllia*], in which I first placed it. But the type species of *Cyclolites* is *C. elliptica* Lamarck, with which the characteristic species of the genus such as *C. undulata* (Goldfuss), *C. polymorpha* (Goldfuss), and *C. discoides* (Goldfuss) agree in all essential particulars. The main difference between *Trochophlegma* and *Cyclolites* is that in the latter the septa are not subequal. In *C. elliptica*, for example, after every four or five equal thin septa, there is one much thicker than the rest. This feature is conspicuous both on the external surface and in thin horizontal sections. The feature is stated in Edwards and Haime's diagnosis of the type species and illustrated in Pratz's figures. It is true that in transverse sections of *Trochophlegma* an apparent inequality of the septa is produced by stereoplastic union of some lines of trabeculae; but in all the Indian specimens the septa externally appear subequal, as shown on Plate XXXIII, fig. 3a or 4c. In *Cyclolites*, moreover, the calicular fossa is a deep, elongated trench, extending nearly across the corallum, whereas in *Trochophlegma* it is small and circular. The more lamellar aspect of the septa of *Cyclolites* is illustrated by Duncan's figures^a of the Sind series of corals belonging to this genus. The same character separates *Procyclolites* Frech, in which the septa are said to develop 'ziemlich schnell zu compacten lamellen; die Zahl der offen bleibenden Poren ist sehr gering und auf die jüngsten Theile der Septa beschränkt.'"

3. Genus CYCLOLITES Lamarck.

1801. *Cyclolites* LAMARCK, Syst. Anim. sans Vert., p. 369.

Original generic diagnosis.—"Corallum free, orbicular or elliptical, convex and lamellate above, flattened below, with concentric circular lines.

"It forms a single lamellate star."

Type species.—*Cyclolites elliptica* Lamarck, Hist. Nat. Anim. sans Vert., II, p. 234.

The following species are placed in the genus:

1. *Cyclolites numismalis* Lamarck.
2. *Cyclolites hemisphaerica* Lamarck.
3. *Cyclolites elliptica* Lamarck.

^aGregory overlooked that Duncan, because of the imperforate septa of these corals, erected a new genus, *Zittelofofungia*, for them. See *Zittelofofungia*, p. 408, of the present paper.

4. *Cyclolites cristata* Lamarek.

However, they are first described in 1816.^a

Of these species Milne Edwards and Haime left *C. numismalis*, *C. hemisphærica*, and *C. elliptica* in the genus *Cyclolites*, referring *C. hemisphærica* to the synonymy of *C. elliptica*.^b

The fourth species, *C. cristata*, belongs to an entirely different genus, *Aspidiscus* Koenig,^c 1825. Therefore the type-species must be *C. numismalis* or *C. elliptica*. Milne Edwards and Haime in 1849^d selected the latter.

Distribution.—Upper Cretaceous, Senonian of Europe.

Remarks.—Pratz in his *Verwandschaftliche Beziehungen einiger Korallengattungen* describes in detail the septal structure of a coral said to be a *Cyclolites*, but unfortunately does not give the name of the species nor does he give any clue by which it can be determined. I broke a specimen of *C. elliptica*, from Gosau, identified by Prof. J. Felix, and find that the septal structure, so far as can be distinguished by means of a hand lens, agrees with Pratz's figure, Plate XIV, fig. 1.^e Therefore I believe that the structure given by Pratz for *Cyclolites* is correct.

The septa of *Cyclolites (elliptica)* are composed of quite small trabeculae, that in general run at right angles to the free edge of the septum. The trabeculae show equally spaced thickenings, those of neighboring trabeculae fusing, leaving regularly arranged pores between them; the septa present a strikingly regular mesh-work appearance. Apparently very near the base the pores tend to be filled. According to Pratz, the pores may be obliterated in the thicker septa. Unfortunately the specimens at my disposition do not permit so thorough a study as I should like to make, but examination of the edges of the thicker septa leads me to believe that this part of the description of Pratz also applies to *C. elliptica*.

The basal wall of *C. elliptica* is perforate and synapticulate beneath the epitheca.

According to Pratz,^f the genus possesses "ausserordentlich feine und sehr zahlreiche Traversen."

The following is a synonym of *Cyclolites*:

EPISERIS de Fromentel, *Introd. à l'Étude Polyp. foss.*, 1858–1861, p. 125.

Original diagnosis.—"The fossil to which Mr. Reuss has given the name *C[yclolites] macrostoma* differs from *Cyclolites* by having a wall at first horizontal, but which later becomes vertical, thus assuming the

^a Hist. nat. Anim. sans Vert., II, pp. 233, 234.

^b See Hist. nat. Corall., III, pp. 40, 44.

^c See Idem, II, p. 387.

^d Comptes rend. Acad. Paris, XXIX, p. 71.

^e Palaeontographica, XXIX, pl. XIV.

^f Idem, XXIX.

form of certain *Montlivaultiæ*; therefore we believe that this species belongs to a different genus. This fossil has a height of 60 mm., a length of about 70 mm. Its sides are covered by bands of epitheca, through which the costæ can be seen here and there. There are about 380 rather strong and thick costæ."

Type species.—*Cyclolites macrostoma* Reuss.

Distribution.—Cretaceous, Turonian of Gosau.

Felix, in his *Anthozoön der Gosauschichten in den Ostalpen*,^a takes no notice of *Episeris* de Fromentel, leaving *Cyclolites macrostoma* Reuss in the genus to which it was originally referred.

4. Genus TROCHARÆA Étallon.

1864. *Trocharæa* ÉTALLON, *Lethæa bruntrutana*, p. 411.

Original generic diagnosis.—"Corallum simple, without epitheca, with the structure of *Microsolena*.

"Very near the genus *Anabacea*; but its septa are more distinctly trabecular, and it differs further by the large attachment of its base."

Type species.—*Trocharæa actiniformis* Étallon, *Lethæa bruntrutana*, p. 411, pl. LVIII, fig. 4.

Distribution.—Jurassic (Hypovirgulian), Switzerland.

Remarks.—Apparently only two species have been referred to this genus, the type species of Étallon and *T. patelliformis* Gregory,^b from the Jurassic, Upper Putehum beds, northwest of Jumara, India. Gregory rediagnoses the genus as follows: "*Microsolenidae* with corallum simple, pedunculate, or sessile, with a broad base. Septa numerous, thin; the trabeculae are isolated above, but united near the base into short series. Calice superficial. Columella parietal; may be well developed." Under the heading "Affinities," he remarks: "This genus is allied to *Anabacia* by its simple corallum, but differs in its shape and in the character of the septa. The trabeculae fuse near the base to a greater extent than in *Anabacia*."

GENERA NOT REFERRED TO FAMILIES.

The data obtainable concerning quite a number of genera are not sufficient to refer them to families. The type-species of each of these genera must be subjected to thorough study. I have divided them into four groups.

I. WALL SOLID, CONDITION OF SEPTA UNKNOWN.

II. SEPTA SOLID, CONDITION OF WALL UNKNOWN.

III. WALL PERFORATE, CONDITION OF SEPTA UNKNOWN.

IV. CONDITION OF NEITHER WALL NOR SEPTA KNOWN.

^a *Palæontographica*, XLIX, 1903, p. 189.

^b *Jurassic Corals of Cutch*, p. 178, pl. II A, figs. 15-20.

I. WALL SOLID, CONDITION OF SEPTA UNKNOWN.

1. Phegmatozeris.
2. Microseris.
3. Asterozeris.

1. Genus PHEGMATOSERIS Milaschewitz.^a

1876. *Phegmatozeris* MILASCHIEWITZ, Palaeontograph, XXI, p. 212. Genus referred to the "*Lophoserine*."

Original generic diagnosis.—"Corallum simple, fan-shaped, pedicellate attached by a narrow base. Calice longitudinally compressed, septa not exsert. Columella absent. The wall is not porous, but beginning at the base is covered with ribs, which correspond to the septa."

Type species.—*Phegmatozeris flabelliformis* Milaschewitz, Palaeontographica, XXI, p. 212, pl. I, figs. 5, 5a.

Geologic horizon and locality.—Jurassic of Nattheim.

Remarks.—I have been unable to find a more detailed account of this genus than that given in the original diagnosis and in the description of the type species.

2. Genus MICROSERIS de Fromentel.

1870. *Microceris* DE FROMENTEL, Paléontol. franç., Crétacé, VIII, Pt. 25, p. 367.

Original generic diagnosis.—"Corallum hemispherical; the wall horizontal, naked, covered with scattered granulations which are not arranged so as to form ribs. Septa large, arched, uniting, fusing in the center, where there is a small, round columellar fossa. Synaptacula rare, but well developed."

Type species.—*Microseris hemispherica* de Fromentel, Paléontol. franç., Crétacé, VIII, p. 368, pl. LXXX, figs. 1-1d.

Distribution.—Cretaceous, Cenomanian, Mans, France.

Remarks.—This genus, according to de Fromentel, differs from *Cycloseris* "by its general appearance and the absence of costae on the lower surface, they being replaced by scattered granulations." He gives no data on the structure of the wall or septa, but his considering it so closely related to *Cycloseris* would indicate an imperforate wall and imperforate septa. The irregularly arranged granulations on the base could scarcely occur on a perforate wall, where the granulations would naturally follow the courses of the septa.

^a Duncan, Jour. Linn. Soc. London, Zool., XVII, p. 148, misspells this name, giving it as *Phragmatozeris*.

3. Genus ASTEROSERIS de Fromentel.

1867. *Asteroseris* DE FROMENTEL, Paléontol. franç., Crétacé, VIII, Zooph., Pt. 24, p. 328.

Original generic diagnosis.—"The corallum is hemispherical, basal wall imperforate, discoid, slightly concave and covered with granulations, which are radially arranged on the margins. The columella but slightly developed, reduced to three or four scarcely visible points. Septa large, unequal, strongly granulated on their upper margins. Pali well developed."

Type species.—*Asteroseris coronula* de Fromentel, Paléontol. franç., Crétacé, VIII, Zooph., Pt. 24, p. 328, pl. XLVIII, figs. 3-3c.

Distribution.—Neocomian of Mans, France.

Remarks.—By a mistake, the name is given at the bottom of Plate XLVIII (which was published in Livraison 12) as *Stephanoseris*.

De Fromentel does not describe the structure of the septa. It can only be inferred from the character of the septal margins—such an inference, of course, is doubtful.

II. SEPTA SOLID, CONDITION OF WALL UNKNOWN.

Zittelofungia.

Genus ZITTELOFUNGIA Duncan.

1884. *Zittelofungia* DUNCAN, Jour. Linn. Soc. London, Zool., XVIII, p. 150.

Original generic diagnosis.—"Corallum free, plano-convex, circular or elliptical in outline, with a flat or slightly concave base, and a convex calice with a circular or oval fossa. Columella absent. Septa very numerous, close, thin, unequal, uniting, crested denticulate or moniliform at the free edge, granular at the sides, imperforate. Synapticula numerous. Dissepiments wanting. Epithea of base in concentric folds, stout or thin.

"Distribution.—Fossil. Eocene: Sind."

Duncan in his Sind fossil corals and Alcyonaria, pp. 52-55, describes nine species which he refers to *Cyclolites*, namely: *C. alpina* (d'Orbigny), *C. ranikoti* Duncan, *C. crenulata* Duncan, *C. vicaryi* Haime, *C. anomala* Duncan, *C. superba* Duncan, *C. haimeii* Duncan, *C. altavillensis* DeFrance, and *C. striata* Duncan. Duncan separated these corals from *Cyclolites* because of their imperforate septa, and proposed for them the generic name *Zittelofungia*. But no type species was designated. The septal structure of not even one of the species is described. Whether it is the same for all can be determined only from an examination of his original material. Until this is done a type species that will fit the original generic diagnosis can not be selected with certainty.

III. WALL PERFORATE, CONDITION OF SEPTA UNKNOWN.

Cyclabacia.

Genus CYCLABACIA.

1866. *Cyclabacia* BÖLSCHÉ, Zeitsch. deutsch. geolog. Gesellsch., XVIII, p. 473.

Original generic diagnosis.—"Corallum simple, free, discoid, arched above, underside more or less flat. Wall perforate. Ribs radiating from the center outward, granulate; the separate granulations sometimes fuse with one another, forming concentric striations. Costæ not alternating at the margin with the septa, but passing directly into them. Epitheca absent. Septa of the first and second cycles straight; those of the other cycles more or less curved and to a great extent uniting with one another. Septal margins dentate. Septal faces strongly granulate, the granulations drawn out into fine points, which show a tendency to unite with those of the neighboring septa. Columella strongly developed or rudimentary."

Type species.—*Cyclabacia stellifera* Bölsche, Zeitsch. deutsch. geolog. Gesellsch., XVIII, p. 474, pl. ix, fig. 3.

Distribution.—Cretaceous, Senonian, North Germany.

Remarks.—Bölsche states that *Cyclabacia* is separated from *Anabacia* by the presence of a perforate wall;^a from *Micrabacia* by the costæ not alternating with the septa, i. e., the costæ and septa are continuous in *Cyclabacia*.

Three species, *Cyclabacia semiglobosa*, *C. stellifera*, and *C. fromenteli*, all of Bölsche, were described and placed in the genus at the time of its publication, and no type species was designated. I have selected the second as the geno-type, because both the description and the figures are satisfactory.

Bölsche unfortunately does not describe the septal structure.

Duncan,^b in his Revision of the Genera and Families of the Madreporaria, placed *Cyclabacia* in the "*Stephanophyllioida*" of the *Eupsammidæ*, remarking that "This is probably identical with *Fungia*, and is therefore a link between *Micrabacia* and *Fungia*." It is difficult to see why he should have placed it systematically so far from where he says it belongs.

IV. CONDITION OF NEITHER THE WALL NOR THE SEPTA KNOWN.

1. Turbinoseris.
2. Elliptoseris.
3. Gonioseris.
4. Epistreptophyllum.
5. Thecoseris.

^a "Von *Anabacia* trennt diese Gattung das Vorhandensein einer durchborten Mauer." This supposed difference is of no value, as the wall of *Anabacia* is synaptical, abundantly perforate. See p. 403.

^b Jour. Linn. Soc. London, Zool., XVIII, p. 174.

1. Genus *TURBINOSERIS* Duncan.

1870. *Turbinoseris* DUNCAN, Paleontograph. Soc., Monog. Brit. Foss. Corals, Sup., Pt. 2, No. 2, p. 42.

Original generic diagnosis.—"The corallum is simple, more or less turbinate, or constricted midway between the base and calice. The base is either broad and adherent or small and free.

"There is no epitheca, and the costae are distinct.

"There is no columella, and the septa unite literally [*sic*] and are very numerous."

Type species.—*Turbinoseris defromenteli* Duncan, Palaeontograph. Soc., Monog. Brit. Foss. corals, Sup., Pt. 2, No. 2, p. 43, pl. xv, figs. 13-18.

Geologic horizon and locality.—Atherfield, England, in the Lower Greensand.

Remarks.—The following additional characters apparently can be deduced from Duncan's description and figures of *T. defromenteli*. He says "the synapticulæ are well developed, and the costae are well developed, and often not continuous with the septal ends." The septa are not positively stated to be imperforate, but figures 15 and 18 so represent them. No discussion of the wall is given, but both figures 13 and 14 represent it as of perforate or synapticulæ composition. Figure 18 illustrates what Duncan says is "the unusual appearance of septa ending in intercostal spaces, magnified." Figure 16, natural size of a calice, shows an apparently imperforate wall, though not of uniform thickness, and the septa in most instances correspond in position with the costae. Although Duncan says there is no columella, one would judge from his figure that a poorly developed, false one is present. A comparison is made with *Trochoseris* in the following words: "The necessity for forming a new genus for this species is obvious. It is the neighbor of *Trochoseris* in the subfamily of the *Lophoserine*. This last genus has a columella and the new has none."

There is quite a large literature on *Turbinoseris*, but no one has as yet published an account of the structure of the type species. The following is a review of the literature:

Duncan, in his *On the Older Tertiary Formations of the West Indies*,^a republishes his original description, adds a note to the effect that it is separated from *Trochoseris* by the absence of a columella, and describes seven new species from the Tertiary of St. Bartholomew.

In his *Sind fossil Corals and Alcyonaria*,^b he describes four more species that he places in *Turbinoseris*, but gives no additional information on the characters of the genus.

^aQuart. Jour. Geol. Soc. London, XXIX, 1873, pp. 558-561.

^bPaleontol. Indica, Ser. XIV, I, 1880, Pt. 2, pp. 49-51.

In his Revision of the Families and Genera of the Madreporaria,^a it is stated that the septa are solid and that the wall is stout, but whether those characters are based on the type species or on a species subsequently referred to the genus can not be determined.

R. F. Tomes, in an article entitled Observations on some imperfectly known *Madreporaria* from the Cretaceous Formation of England,^b declares that *Turbinoseris* is a synonym of *Leptophyllia* Reuss, but as he does not describe the structural details of the wall or septa, he can not be considered to have proven his contention.

Duncan, in the next volume of the same journal, published An Answer to Observations on some imperfectly known Madreporaria, etc., by Tomes, in which he denies the identity of *Turbinoseris* and *Leptophyllia*, and says positively that "the septa [of the former] are solid."^c But Duncan does not state explicitly that this is the condition in *Turbinoseris defromenteli*.

In July, 1899, Mr. Tomes published an article, Observations on some British Cretaceous Madreporaria, with the Description of two new Species, in which^d he not only places *Turbinoseris* in the synonymy of *Leptophyllia*, but refers *Turbinoseris defromenteli* to the synonymy of *Leptophyllia clavata* Reuss, the type species of the latter genus, but he does not present evidence of a convincing kind to sustain his conclusion. Tomes identifies another specimen from the Lower Greensand, at Sandown, Isle of Wight, with *Leptophyllia irregularis* Reuss.

In September, 1899, my paper on Some Cretaceous and Eocene Corals from Jamaica was published. In it^e I pointed out the unsatisfactory definition of the genus, and added a few remarks based on Duncan's original figures. Two additional species, closely related to those from St. Bartholomew, were described. There I made the statement, "I have referred the two Jamaican corals to *Turbinoseris* on the strength of their resemblance to the species from St. Bartholomew, but whether Duncan was correct in referring the latter corals to that genus must be left to future work."

Gregory, in The Corals, Jurassic Fauna of Cutch,^f makes some remarks on *Turbinoseris*, basing them on Duncan's description, figures and subsequent notes. He contributes no observations of his own.

Felix, in his Anthozoen der Gosauschichten in den Ostalpen,^g expresses doubt as to the correctness of Tomes's identification of the

^a Jour. Linn. Soc. London, Zool., XVII, 1884, p. 148.

^b Geol. Mag., New Ser., Dec. III, II, 1885, pp. 550, 551.

^c Idem, Dec. III, III, 1886, pp. 54, 55.

^d Idem, Dec. IV, VI, 1899, p. 306.

^e Bull. Mus. Comp. Zool., XXXIV, pp. 243, 244.

^f Palæontol. Indica, Ser. IX, II, Pt. 2, 1900, p. 163.

^g Palæontographica, XLIX, 1903, pp. 201, 202.

English Lower Greensand species with the Austrian Gosau forms. Felix says:

Tomes is inclined to refer to *Leptoph. clavata* Rs., the species first described by Duncan as *Turbinoseris defromenteli* from the Lower Greensand of Atherton, and later designated by himself [Tomes] as *Leptophyllia anglica*. He determines still another coral from the Lower Greensand of the Isle of Wight as *Leptophyllia irregularis* Rs., which is separable from the Gosau form only by its somewhat thicker septa and costæ; but unfortunately the number of these is not given. However, one obtains the impression, from an inspection of the accompanying figure, that the number of septa would be essentially smaller than on a specimen of the same size of *L. irregularis* from Gosau. Furthermore, the specific identity of the forms would be very surprising when there is so much difference in geological horizon and so great a distance between the localities.

The genus *Turbinoseris* has been discussed in the literature at least ten different times, but as yet no adequate description of it has been published. A detailed description of the septal and mural structure of *Turbinoseris defromenteli* must be published, and should be accompanied by figures, before it can be known whether the genus should be considered valid or should be referred to the synonymy of some other.

2. Genus ELLIPTOSERIS Duncan.

1880. *Elliptoseris* DUNCAN, Sind foss. Corals and Alcyonaria, Palæontol. Indica, Ser. XIV, I, p. 48.

Genus referred to *Lophoserina*.

Original generic diagnosis.—"The corallum is simple, conical, compressed, with a largely open, elliptical calice. There are costæ, but no epitheca; there is no columella, but an elongate and deep axial space. The septa are numerous, and the smaller join those between them near the axial space. There are pali before the joined septa. Synapticulæ are numerous in the calice."

Type species.—*Elliptoseris aperta* Duncan, Sind foss. Corals and Alcyonaria, Palæontol. Indica, Ser. XIV, I, p. 48, pl. VIII, figs. 3-6.

Geologic horizon and locality.—Lower Eocene (Ranikot group), Jhirk, India.

3. Genus GONIOSERIS Duncan.

1872. *Gonioseris* DUNCAN, Brit. foss. Corals, Sup., Pt. 3, p. 21.

Original generic diagnosis.—"The corallum is simple and free. The base is polygonal in outline and the projecting angles are formed by groups of costæ terminating in septa. Between the angles the margin is concave externally. The center of the base is concave. The costæ are numerous and they cover the base. Many converge at each angle along a line leading from the large septum to the center. The upper surface of the corallum is convex, and is divided by masses of septa which are continuous with the angles of the base, and which,

after projecting there, become exsert and pass to the axial space where they meet. There is a large, prominent, primary septum in each mass. The calicular wall is invisible. The synapticulæ are broad and numerous."

Type species.—*Gonioseris angulata* Duncan, Brit. foss. Corals, Sup., Pt. 3, p. 21, pl. VII, figs. 1-5.

Distribution.—Jurassic, Inferior Oolitic, Cloughton Wyke, near Scarborough, England.

Remarks.—Duncan does not give any detailed information regarding the character of the wall or the structure of the septa. His figure (Plate VII, fig. 5) of *G. angulata* represents the septa as solid. The type species of this genus needs a thorough investigation.

4. Genus EPISTREPTOPHYLLUM Milaschewitz.

1876. *Epistreptophyllum* MILASCHEWITZ, Palæontographica, XXI, p. 211.

Original generic diagnosis.—"Corallum simple, conical or cylindrical, firmly attached to some object, columella well developed, spongy. Calice excavated, septa numerous, not exsert. Outer surface of the wall covered with equal ribs. Low down in the interseptal loculi besides endothecal dissepiments are numerous synapticulæ; in the upper part numerous pointed or wart-shaped granulations occur on the septal faces."

Milaschewitz remarks: "This remarkable genus can be referred either to the family *Astræidæ* or the *Fungidæ*, as it unites the characteristic features of both families. In consequence of the presence of synapticulæ it would belong to the *Fungidæ*; because of the presence of endothecal dissepiments, also because of its tall, sometimes perfectly cylindrical form and its excavated calice it appears more nearly related to the *Astræidæ*. However, according to the rows of granulations on the septal faces being parallel to the free margins of the septa, instead of being vertical as in the *Fungidæ*, the genus shows a greater relationship to the subfamily *Eusmilinæ*, which have septa with entire margins, than with the subfamily *Astræinæ*, which have dentate septa with vertical rows of granulations."

Type species.—Three species are referred to *Epistreptophyllum* by its author, *E. commune* Milaschewitz, *E. cylindratum* Milaschewitz, and *E. tenue* Milaschewitz, all from the Jurassic of Nattheim. No species is designated as the geno-type, nor are the details of the structure of the wall or of the septa given. Without making a careful study of Milaschewitz's original material it is not safe to designate a type species.

Epistreptophyllum was made by Zittel^a the type of his *Epistreptophyllinæ*, a subfamily of the *Astræidæ*.

^aHandb. Palæontologie, I, 1880, p. 249.

Ogilvie in her *Korallen der Stramberger Schichten*^a attempted to give more detail concerning the genus. She remarks (p. 252):

Unfortunately the Nattheim specimens of *Epistreptophyllum* do not permit a minute, microscopical investigation. However, many conclusions concerning the finer septal structure can always be drawn from the superficial sculpture of the septa. It is important that the septa are often interrupted and that the separated pieces form in the center a spongy columella. The synaptacula likewise occur irregularly and give to the septa more often a Eupsammid septal appearance. The Stramberg specimens, which agree in all external characters with the Nattheim forms, are better preserved and show the finer septal structure characteristic for the *Eupsammidae*. Thus the systematic position of the genus *Epistreptophyllum* is made clear, and at the same time its near relation to the synchronous simple *Haaparva* and the compound *Diplarva* is shown.

Ogilvie does not mention on which of Milaschewitz's species she based her remarks. However, she identified one of her Stramberg species with *E. commune*. If we could assume her identification as correct, *E. commune* would become the geno-type.

Ogilvie's recharacterization of the genus:

Corallum simple, conical or cylindrical, calice rather deep; septa very numerous and thin, separated now and then into individual trabecular members. Granulations on the septal faces not regularly arranged and of very dissimilar size, many developed as pseudosynaptacula. True synaptacula and numerous vesicular dissepiments present. Columella spongy, large, composed of free and interlacing trabecular members of the longer septa. No true wall, only a pseudothecal thickening of the septal and interseptal skeletal parts near the outer edge. Epithea thin, wrinkled, extending to margin of the calice.

Ogilvie regards *Lithoseris* Koby as a synonym of *Epistreptophyllum*. Gregory thinks her opinion "probably correct." For a fuller discussion see *Lithoseris*, p. 398.

5. Genus THECOSERIS de Fromentel.

1870. *Thecoseris* DE FROMENTEL, Paléontol. franç., Crétacé, VIII, Pt. 25, p. 367.

Original generic diagnosis.—"Corallum elevated and regularly turbinate; columellar fossa, when present, round; usually the septa meet in the center, where they fuse and simulate a papillary columella, but which really does not exist. The septa are thin, numerous, often anastomosing and finely denticulate; they are never exsert, and the calice is usually concave. The epithea is strong, well developed, much folded, and extends to the edge of the calice."

Type species.—*Thecoseris patellata* de Fromentel and Ferry, Paléontol. franç., 1st ser., Jurassique, Pt. 18, pl. LVIII, fig. 2, 1869.

Distribution.—Jurassic, Lias, France.

Remarks.—The structure of neither the wall nor the septa is described. The figures of the type species indicate an imperfect,

^aPaléontogr., Sup., II, 1897, pp. 248-255.

synapticulate wall, and the septa probably are somewhat perforate near their upper edges. But to determine these points positively the type species must be restudied.

M. Koby,^a in his *Monographie des Polypiers jurassiques de la Suisse*, refers six species to this genus, but gives no data based on the type species.

GENERA PROBABLY ERRONEOUSLY PLACED IN THE FUNGIDA.

Corallum discoid or low (*with a parasitic worm in the base*); columella papillary, no epitheca:

With pali (before all septa except the last cycle).

Stephanoseris Milne Edwards and Haime

Without pali..... *Psammoseris* Milne Edwards and Haime

1. Genus STEPHANOSERIS Milne Edwards and Haime.

1851. *Stephanoseris* MILNE EDWARDS and HAIME, Arch. Mus. Hist. Nat. Paris, V, p. 127.

Placed in the *Lophoserinae*.

Original generic diagnosis.—"Corallum short, attached to a shell which it completely surrounds; wall naked, strongly granulated, scarcely striate below; columella papillary, slightly developed; septa much elevated, subentire, very granulated laterally, those of the penultimate cycle more developed than those of the last; pali before all the cycles except the last."

Type species.—*Heterocyathus roussæanus* Milne Edwards and Haime, Ann. Sc. nat., 3d ser., IX, p. 324, pl. x, figs. 9, 9a.

Distribution.—Recent, Zanzibar

Remarks.—Von Marenzeller^b says, in his *Ueber einige Japanische Turbinoliden*, that "The investigation of the preceding *Heterocyathus* [*H. japonicus* (Verrill) v. Marenz. = *Stephanoseris japonica* Verrill] leads me to make some remarks on the earlier described species. It should be emphasized that the genus *Stephanoseris*, erected by Milne Edwards^c for *Heterocyathus roussæanus*^d because it possesses synapticula, is not valid. It must be assumed that the pointed granules of two neighboring septa fuse and produce the impression of synapticula. The whole structure of the corallum, which is reported to be attached to a gastropod shell indicates *Heterocyathus*. Tenison-Woods^e and Moseley^f are of the same opinion, and it is surely only a *lapsus calami* when the latter says in another place^g that *Heteropsammia* and *Stephanoseris* should be united in one genus. Certainly, instead of

^a Schweiz. pal. Gesellsch., Abhand., XIII, 1886, pp. 332-338.

^b K. K. Naturhist. Hof-Museum, Wien, Ann., III, 1888, pp. 17-18.

^c Hist. nat. Corall., III, p. 56.

^d Ann. Sci. nat., 3d ser., zool., IX, 1848, p. 324, pl. x, fig. 8.

^e Proc. Linn. Soc. New South Wales, II, 1878, p. 297.

^f Deep Sea Cor., Challenger Repts., 1880, p. 145.

^g Idem., p. 197.

Stephanoseris it should be '*Psammoseris*.' *Psammoseris* bears the same relation to the Eupsammid genus *Heteropsammia* as *Stephanoseris* to the Turbinolid genus *Heterocyathus*. In this genus, also, only false synaptacula are present, and it, also, must fall."

Von Marenzeller considers that two of Milne-Edwards and Haime's species belong to *Heterocyathus*, namely, *H. acquiricostatus* and *H. [Stephanoseris] roussacanus*. Verrill added one species of *Heterocyathus*,^a *H. alternatus*; and von Marenzeller places the three species of *Stephanoseris*, *S. lamellosa*,^b *S. japonica*,^c and *S. sulcata*,^d in the same genus. Other species of *Heterocyathus* have been described, but they need not be noticed here.

From an examination of the literature, I am inclined to believe that Tenison-Woods, Moseley, and von Marenzeller are correct in considering the type species of *Stephanoseris* a *Heterocyathus*, but unfortunately the studies on the relations of these genera are based only on literature; before certainty can be obtained the type species must be studied.

Professor Verrill says, concerning *Stephanoseris lamellosa*, "Wall rudimentary, represented near the margin only by trabicular processes." As Professor Verrill described one species of *Heterocyathus*, and differentiated his species of "*Stephanoseris*" from that genus, I am inclined to believe that none of the species referred by him to the latter genus belong to the former. I strongly suspect that von Marenzeller's *Heterocyathus japonicus* (Verrill) is incorrectly identified. What final disposition must be made of the Verrill species must be left to future work.^e

^a Proc. Essex Inst., IV, 1865, p. 149; also, V, 1866, p. 41, pl. II, figs. 6, 6a.

^b Idem, IV, p. 149; V, p. 46, pl. II, figs. 4, 4a.

^c Idem, V, p. 47.

^d Idem, V, p. 48.

^e Since this manuscript was sent to press I have been able to study in the Yale University Museum the types of Professor Verrill's species of *Stephanoseris*. I made the following notes:

Stephanoseris japonica Verrill. Type, No. 767, Yale Univ. Mus. Wall perforate, distinctly costate, costae alternating in size. Septa perforate, with typical Eupsammid arrangement.

Stephanoseris sulcata Verrill. Type, No. 764, Yale Univ. Mus. Wall perforate, distinctly costate, costae alternating in size. Septa perforate, with typical Eupsammid arrangement.

Stephanoseris lamellosa Verrill. Type, No. 766, Yale Univ. Mus. Wall perforate, distinctly costate, costae alternating in size. Septa perforate, with typical Eupsammid arrangement.

The genus, to which these species belong, is not closely related to *Heterocyathus*. They are Eupsammids, very close to *Balanophyllia*, from which they are separated by their apparent commensalism with a Sipunculid worm. Every specimen is attached to a small gastropod shell, and has a small wormhole in its base. The genus is separated from *Heteropsammia* by its well-developed costae. Most probably Verrill's *Stephanoseris* is not the *Stephanoseris* of Milne Edwards and Haime, it may be an undescribed genus.

2. Genus PSAMMOSERIS Milne Edwards and Haime.

1851. *Psammoseris* MILNE EDWARDS and HAIME, Arch. Mus. Hist. Nat. Paris, V, p. 127.

Placed in the *Lophoserinæ*.

Original generic diagnosis.—"Corallum discoid, attached to a shell which it completely surrounds; wall naked, strongly granulate, scarcely striate below; columella papillary; septa slightly elevated, very thick, covered on their free edges and their faces with very prominent and extremely crowded granulations, those of the penultimate cycle much more developed than those of the last."

Type-species.—*Heterocyathus hemisphaericus* J. E. Gray, Proc. Zool. Soc. London, for 1849, p. 77, *Radiata*, pl. II, figs. 3, 3a, 4; also Ann. and Mag. Nat. Hist., 2d ser., V, 1850, p. 410.

Distribution.—Recent, China seas.

Remarks.—"The systematic position of this genus is in doubt. Moseley was evidently of the opinion that *Heteropsammia* and *Psammoseris* should be united," although, probably by a *lapsus calami*, he says *Heteropsammia* and *Stephanoseris*. Von Marenzeller has expressed the same opinion.^b

Family STYLOPHYLLIDÆ Volz.^c

1896. *Stylophyllidæ* VOLZ, Palæontographica, XLIII, pp. 85, 86.

Volz gives^d a careful description of the septa, endotheca, wall, and mode of growth. His description will not be repeated here.

The following two genera, *Stylophyllum* Reuss and *Stylophyllopsis* Frech, can scarcely be referred to the *Fungida*, but, as they are very interesting forms to study in connection with a possible phylogeny of the Fungids and Eupsammids, they are included in this paper.

1. Genus STYLOPHYLLUM Reuss.

1854. *Stylophyllum*, REUSS, Denksch. Akad. Wissensch. Wien, Mat. Naturhist. Cl., VII, p. 132.

Original generic diagnosis.—"The form of the corallum unknown; but its upper surface must have been plain or only slightly arched.

"The thick prismatic, irregularly polygonal corallites are directly grown together. The thick walls are compact and entire, without a trace of pores or perforations. In both the transverse and longitudinal sections the line along which the walls of neighboring corallites have fused can be seen.

^a Deep Sea Corals, Challenger Reports, p. 197.

^b K. K. Naturhist. Hof-Museum, Wien, Ann., III, 1888, p. 18.

^c These corals are not considered to belong to the *Fungida*. They are included because of the interest in comparing them with the *Fungida* and the *Eupsammidæ*.

^d Palæontographica, XLIII, pp. 85-86.

"The corallites are divided by numerous thin tabulæ, which are close together and are not horizontal, but concave upward and bowl-shaped. The tabulæ are not regular, but are curved and crumpled, the vertical section (Plate XXI, fig. 3) and the horizontal cross section (Plate XXI, fig. 2) show their irregular form. From the tabulæ, shorter and still thinner partitions originate, which run irregularly, obliquely from one tabula to another, joining them together, and thus forming smaller vesicular spaces.

"The development of the radial lamellæ is very rudimentary. They are built up of thin spine-like pillars of very uneven height, which stand in numerous, but in only slightly regular radial rows on the tabulæ. Some of these stand so near together in the same row that they fuse; others are so long that they extend through several platforms of the tabulæ, the latter appearing to be spread out between them."

Ogilvie, in her *Korallen der Stramberger Schichten*,^a expresses the opinion that *Stylophyllum* and *Stylophyllopsis* are probably related to the *Eupsammiæ*. She says: "*Eupsammia* is, because of the irregular structure and arrangement of the trabeculæ especially remarkable. Pratz has already described a similar irregularity of the trabeculæ in the Jurassic genera *Haplaræa* and *Diplaræa*, also in the recent *Coscinaræa*. Also the Triassic genera *Stylophyllum* and *Stylophyllopsis* show in their septal structure great agreement with *Haplaræa*, etc., i. e., the single trabecula-members are separated more and more toward the center of the calice and form there a loose, spongy tissue."

Volz, in his *Korallen der Schichten von St. Cassian in Süd-Tirol*,^b elevates Frech's *Stylophyllinæ* to family rank, calling them the *Stylophyllidæ*. He describes a new compound genus, *Hexastræa*,^c which he places in that family, and also refers to it Duncan's *Cyathocœnia*.^d

This family of the *Stylophyllidæ* shows some suggestive resemblances to the simple fungid genera, such as *Frechia* Gregory. *Frechia*, however, has no dissepiments and a few synapticula.

Type species.—*Stylophyllum polycanthum* Reuss, Denksch. Akad. Wissensch. Wien, Mat. Naturhist. Cl., VII, p. 133, pl. XXI, figs. 1-3.

Distribution.—Triassic, Gosau district, Austria.

Remarks.—Frech, in his *Korallen Fauna der Trias*,^e referred *Stylophyllum* to his *Astracidæ* and placed it with *Stylophyllopsis* Frech (new genus) in a subfamily, the *Stylophyllinæ*. He emended *Stylophyllum* as follows: "The corallum forms simple calices, with or without lateral buds, as well as massive stocks, which possess a simi-

^a Palæontographica, Supp., II, p. 85.

^b Idem, XLIII, 1896, p. 85.

^c Idem, p. 90.

^d Idem, p. 92.

^e Idem, XXXVII, 1890, p. 42.

larly developed internal structure. Septa proper are not present. The septal spines grow together at the bottom, but they are free above. Traces of a bilateral arrangement of the septal spines was sometimes observed in the simple corals. The endotheca is in the form of concave, rather regular dissepiments or convex vesicles, without there being a distinct boundary between the two forms of development. In the case of small species (also in those of large species that have remained small) the dissepiments appear as tabulae."

The stratigraphic distribution is given as "Upper Muschelchalk, Zlambach beds, Hallstätter Chalk, Hauptdolomit, and the Rhaetic."

2. Genus *STYLOPHYILLOPSIS* Frech.

1890. *Stylophyllopsis* FRECH, *Palaeontographica*, XXXVII, p. 48.

Original generic diagnosis.—"Simple or only slightly branched; in cross-section agreeing quite closely with *Montlivaltia*, in longitudinal section agreeing with *Stylophyllum*."

Distribution.—Norian stage, Rhaetic, lower and middle Lias.

Type species.—*Stylophyllopsis polyactis* Frech, *Palaeontographica*, XXXVII, p. 48, pl. XII, fig. 3, pl. XIV, figs. 17-23, text fig., p. 49. Frech refers six species to this genus: *Stylophyllopsis polyactis* Frech; *S. zittelli* Frech, *S. rudis* (Emmerich) (as *Fungia*), *S. caespitosa* Frech, *S. mojsvari* Frech, and *S. lindströmi* Frech, but designated no type species.

Remarks.—Regarding this genus, Frech says: "The septa form a transition between the isolated spines of *Stylophyllum* and the compact lamellae of *Montlivaltia* (bezw. *Thecosmilie*). The septal spines in a cross-section are seen near the center (Plate x, figs. 10a, 12), quite exceptionally in other places. In a longitudinal section they appear in an isolated condition in the same place; furthermore, as can be especially well seen on weathered surfaces, the spines of the upper portions of the septa are only loosely fused with one another. The upper margins of the septa are distinctly and deeply toothed."

OUTLINE OF THE CLASSIFICATION.

The following outline, which is accompanied by page references, will, it is hoped, facilitate the use of the classification.

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^aReference from Milne Edwards and Haime, Hist. nat. corall., II, p. 327.

DESCRIPTIONS OF NEW GENERA AND SPECIES OF MAMMALS FROM THE PHILIPPINE ISLANDS.

By EDGAR A. MEARNs,

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Early in the year 1903, the Philippine Scientific Association was formed for the purpose of making known the physical resources of the Philippine Islands and gathering materials for the Government Museum of the United States. The author undertook the study of mammals, and on a part of his collection the present paper is based, the greater part having been identified, and the remainder forwarded to Mr. Gerrit S. Miller, jr., Assistant Curator, Division of Mammals, U.S. National Museum, for determination. Mr. Miller is now engaged in studying types of East Indian mammals at the British Museum, where the most difficult forms can be identified by actual comparison with Philippine types. The collection is still so meager that a general report on the mammals, even of the southern islands of the Philippine group, would be premature.

I am indebted to the authorities of the U. S. National Museum for affording me every facility and convenience in working up the collection. My thanks are especially due to Dr. R. Rathbun, Assistant Secretary, Smithsonian Institution, and to Mr. G. S. Miller, jr.; and I received much direct assistance from Mr. Walter L. Hahn, Dr. Marcus W. Lyon, jr., and Dr. Leonhard Stejneger, of the Museum staff, to each of whom I express my sincere and grateful appreciation.

The new genera described are as follows:

Urogale (p. 435). Type: *Urogale cylindrura*, new species.

Podogymnura (p. 436). Type: *Podogymnura truei*, new species.

Bullimus (p. 450). Type: *Bullimus bagobus*, new species.

Limnomys (p. 451). Type: *Limnomys sibuanus*, new species.

Tarsomys (p. 453). Type: *Tarsomys apoensis*, new species.

Apomys (p. 455). Type: *Apomys hylocates*, new species.

The new species and subspecies described are as follows:

Cynomolgus mindanensis, p. 428.
Cynomolgus mindanensis apocensis, p. 429.
Cynomolgus suluensis, p. 430.
Cynomolgus cagayanus, p. 431.
Pteropus lucensis, p. 432.
Pteropus cagayanus, p. 433.
Urogale cylindrura, p. 435.
Podogymnura truei, p. 437.
Mus lagulayensis, p. 439.
Mus albicularis, p. 440.
Mus magnirostris, p. 441.
Mus mindanensis, p. 442.
Mus zamboangae, p. 443.

Mus kelleri, p. 444.
Mus todayensis, p. 445.
Mus vulcani, p. 446.
Mus vulcani apicis, p. 447.
Mus pantarensis, p. 448.
Mus commissarius, p. 449.
Bullimus bagobus, p. 450.
Limnomys sibuanus, p. 452.
Tarsonomys apocensis, p. 453.
Apomys hyllocates, p. 456.
Apomys petrus, p. 458.
Apomys insignis, p. 459.

CYNOMOLGUS Reichenbach. (1863.)

MACAQUES OR LONG-TAILED GREEN MONKEYS.

Meyer, in his valuable work on the mammals of the Celebes and Philippine archipelagoes, expressed the opinion that when a sufficient number of specimens of these monkeys shall have been assembled from the various islands of the Philippine group characters may be discovered to separate races or species from certain islands or groups of islands. The U. S. National Museum has now acquired 21 specimens from five different islands, and a study of this material has convinced me that the constant differences found in specimens from the islands of Luzon, Mindanao, Sulu, and Cagayan Sulu entitle the forms from these islands to be considered as distinct from each other and from the old species, *Cynomolgus fascicularis* (*Macacus cynomolgus* of authors). A single immature specimen (Cat. No. 125326, U.S.N.M.) from Basilan Island does not show any characters to separate it from the Macaque of the neighboring island of Mindanao. The forms which I recognize are as follows:

CYNOMOLGUS PHILIPPINENSIS Isidore Geoffroy.

MANILA MACAQUE.

Chongo (native Tagalo name).

Macacus philippinensis ISIDORE GEOFFROY, Archiv. du Mus., II, p. 568, pl. v; Catal. des Primat., 1851, p. 29 (based on an albino from Manila, Luzon, Philippine Islands).

Macacus palpebrosus ISIDORE GEOFFROY, Catal. des Primat., p. 93; Archiv. d. Mus., V, p. 543 (based on normal coloration; specimen also from Manila).—WAGNER, Schreb., S. Suppl., 1855, V, p. 54.

The U. S. National Museum has recently acquired four good specimens of the Luzon Macaque from the province of Batangas, Luzon, Philippine Islands (Nos. 114139 to 114142, U.S.N.M.). The following description is based on these specimens:

Color.—Like all the species of this group the pelage of the upperparts and outer surface of limbs is annulated with light and dark. The light rings and glossy texture of the hair give these parts a changing hue when viewed in different lights. The general effect is as follows: Upperparts mummy brown, the hairs everywhere annulated with blackish; top of head strongly tinged with chestnut; sides of head grizzled yellowish olive; forehead ornamented with a brow of stiff black hairs, scarcely separated from the naked orbits by a narrow rim of short, brown hair, which is cut off by intervening black in the center; underparts, including inner surface of limbs, scantily clothed with pale drab-gray hairs of a very silky texture; genitals, broccoli brown; outer surface of limbs, mummy brown, mixed with smoke gray on wrists, ankles, feet, and hands; tail, grayish black above, hair brown below, with a gradual blending of these colors on the sides of the tail.

Cranial measurements of two adult females from Batangas, Luzon.

Measurement.	No. 114140,	No. 114141,
	U.S.N.M.	U.S.N.M.
	mm.	mm.
Greatest length (exclusive of incisors)	110	110
Basal length	83	81
Basilar length	79	76
Least palatal length	44	42
Palatal breadth (between front molars)	18	19
Zygomatic breadth	70	66
Mastoid breadth	58	55
Greatest breadth of braincase above roots of zygomata	56	55
Least breadth of braincase immediately behind orbits	40	40
Orbital breadth	57	55
Least distance from orbit to alveolus of inner incisor	37	32
Greatest depth of braincase (exclusive of sagittal crest)	43	43
Mandible	80	78
Greatest depth of ramus	16	16
Maxillary tooththrow (exclusive of incisors)	36	37
Mandibular tooththrow (exclusive of incisors)	39	40
Crown of middle upper molar	7.3 - 7.1	7.6 - 7.1
Crown of middle lower molar	7.6 - 6	7.8 - 6.1

Remarks.—Measurements taken from skins of monkeys are so unsatisfactory that I have omitted them. Skulls indicate that the size of the Luzon form is about the same as that from Mindanao, but the smaller size of the foramen magnum in all of the Luzon skulls would indicate a more slender animal.

Specimens examined.—Four, two adult females and two immature males, all from Batangas, Batangas Province, Luzon, Philippine Islands.

CYNOMOLGUS MINDANENSIS, new species.

MINDANAO MACAQUE.

Chongo (Visayans of Mindanao).*Ahm'-mo* (Moros of Mindanao).

Type.—Adult male (skin and skull), Cat. No. 123450, U.S.N.M. Collected at Pantar (altitude 1,900 feet), Mindanao, Philippine Islands, August 26, 1903, by Edgar A. Mearns. (Original number, 5620.)

Characters.—Stouter than *Cynomolgus philippinensis*, and different in color.

Color.—Upperparts raw umber, the hairs everywhere annulated with blackish; top of head strongly washed with burnt umber; sides of head pale grayish olive; forehead with grizzled brown front, ornamented with long, stiff, black hairs, forming a bushy brow; underparts pale drab-gray; genitals broccoli brown; outer surface of limbs tawny-olive, becoming drab-gray on the fingers and toes; tail slaty black at base above, becoming paler toward the extremity, and olive-drab below, with a few tawny annuli to the hairs of the upper side near the base. The young are grayer and less brownish.

Skull and teeth.—Comparing skulls of adult females, the foramen magnum is larger than in *Cynomolgus philippinensis*; and the lambdoidal crests are more arched and wider, showing less posterior expansion of the braincase. Teeth similar.

Cranial measurements of six specimens from Pantar, Mindanao.

Measurement.	No. 123449, U.S.N.M., female.	No. 123455, U.S.N.M., female.	No. 123448, U.S.N.M., male.	No. 123450, U.S.N.M., male, type.	No. 123453, U.S.N.M., male.	No. 123456, U.S.N.M., male.
	mm.	mm.	mm.	mm.	mm.	mm.
Greatest length (exclusive of incisors)	105	110	121	125	122	121
Basal length	78	82	93	97	92	91
Basilar length	72	80	90	94	88	87
Least palatal length	42	44	52	56	49	50
Palatal breadth (between front molars)	20	20	21	24	21	23
Zygomatic breadth	68	70	82	83	79	83
Mastoid breadth	53	55	65	64	64	65
Greatest breadth of braincase above roots of zygomatics	54	55	59	57	57	59
Least breadth of braincase immediately behind orbits	39	40	40	41	40	39
Orbital breadth	55	55	65	62	61	65
Least distance from orbit to alveolus of inner incisor	35	35	40	45	42	41
Greatest depth of braincase (exclusive of sagittal crest)	43	45	47	45	45	46
Mandible	78	80	88	91	89	90
Greatest depth of ramus	16.5	17	17	17.5	18	18
Maxillary toothrow (exclusive of incisors)	34	36	40	38	40	43
Mandibular toothrow (exclusive of incisors)	38	41	48	46	45	49
Crown of middle upper molar	7.1×6.9	7.1×7	8×8	7.5×7.8	7.5×7	8×8
Crown of middle lower molar	7.2×5.3	7.5×5.9	8.3×6.3	7.5×6	7.5×5.8	8×7

External measurements of type (weight 15 pounds avoirdupois).—Total length, 1100; tail vertebrae, 600; tail hairs, 633; hind foot, 137; head, 143; ear above crown, 32; ear above notch at base, 39.

Remarks.—The caecum had the human three folds, but lacked an *appendix vermiformis*.

Specimens examined.—Eleven skins, 10 with skulls (one skull, Cat. No. 123451, U.S.N.M., missing), 9 from Pantar, Mindanao (Nos. 123448–123456, U.S.N.M.); 1 from the mouth of the Sulug River on the east side of the Gulf of Davao, southern Mindanao (No. 125323, U.S.N.M.); and 1 (No. 125326, U.S.N.M.) from the island of Basilan (off Zamboanga, Mindanao).

CYNOMOLGUS MINDANENSIS APOENSIS, new subspecies.

MOUNT APO LONG-TAILED GREEN MONKEY OR MACAQUE.

Loo'-toong (Bagobo natives of Mount Apo).

Type.—Adult female (skin and skull), Cat. No. 125321, U.S.N.M. Collected on Mount Apo at the altitude of 6,000 feet, southern Mindanao, Philippine Islands, June 25, 1904, by Edgar A. Mearns. (Original number, 5670.)

Characters.—Similar to *Cynomolgus mindanensis*, but paler and different in color.

Color.—Upperparts yellowish olive, the hairs everywhere annulated with blackish; top of head slightly washed with burnt umber; sides of head pale olivaceous gray, annulated with darker; forehead pale olivaceous gray, separated from the crown by a strong fringe of stiff black hairs; face gray; underparts whitish smoke gray; genitals bistre; outer surface of limbs pale yellowish olive, changing to olive-gray on lower portion and on hands and feet; upper side of tail slate-black at base, fading to mouse gray on terminal half, and smoke gray on under side. Young, and nearly mature specimens, are colored almost exactly like the two old females.

Skull and teeth.—Compared with *C. mindanensis mindanensis* the rostrum is shorter, and the braincase wider, the zygomatic arches more expanded, orbital breadth slightly greater, and the molariform teeth slightly narrower.

Specimens examined.—Four skins with skulls, all from Mount Apo at 6,000 feet altitude, June 25 to 29, 1904. Females not pregnant.

Cranial measurements of adult female from Mount Apo, southern Mindanao.

Measurement.	No. 125321, U.S.N.M., type.
	mm.
Greatest length (exclusive of incisors).....	107
Basal length.....	80
Basilar length.....	75
Least palatal length.....	39
Palatal breadth (between front molars).....	19.5
Zygomatic breadth.....	72
Mastoid breadth.....	58
Greatest breadth of braincase above roots of zygomata.....	56
Least breadth of braincase immediately behind orbits.....	41
Orbital breadth.....	56.5
Least distance from orbit to alveolus of inner incisor.....	30
Greatest depth of braincase (exclusive of sagittal crest).....	45
Mandible.....	78
Greatest depth of ramus.....	15.5
Maxillary toothrow (exclusive of incisors).....	35
Mandibular toothrow (exclusive of incisors).....	40
Crown of middle upper molar.....	7.1 × 6.4
Crown of middle lower molar.....	7 × 5.8

External measurements of two adult females from Mount Apo, southern Mindanao.

Measurement (from fresh specimens).	No. 125321, U.S.N.M., type.	No. 125322, U.S.N.M., topotype.
	mm.	mm.
Total length.....	900	910
Tail vertebrae.....	455	445
Hind foot.....	128	120
Head.....	117	120
Ear above crown.....	31	30
Ear above notch at base.....	35	35

Measurements of two specimens from Mount Apo, southern Mindanao.

Measurement (from fresh specimens).	No. 125319, U.S.N.M., immature female tototype.	No. 125320, U.S.N.M., young male tototype.
	mm.	mm.
Total length.....	780	690
Tail vertebrae.....	400	350
Hind foot.....	111	103
Head.....	106	98

CYNOMOLGUS SULUENSIS, new species.**SULU MACAQUE.**

Type.—Adult male (skull without skin), Cat. No. 125324, U.S.N.M. Collected at the foot of Crater Lake Mountain, on the island of Sulu, Philippine Islands, November 16, 1903, by Edgar A. Mearns. (Original number, 5750.)

Characters.—Larger than *Cynomolgus mindanensis* or *C. philippinensis*, with different coloration (from my recollection) and cranial characters.

Skull and teeth.—Compared with *C. mindanensis* the skull is larger, with relatively wider frontal and zygomatic arches; rostrum shorter

and broader; audital bullæ more rounded; molariform teeth smaller, without marginal tubercles on inner border.

Cranial measurements of the type, an adult male, from Sulu.

Measurement.	No. 125324, U.S.N.M., type.
	mm.
Greatest length (exclusive of incisors).....	126
Basal length.....	96
Basilar length.....	92
Least palatal length.....	51
Palatal breadth (between front molars).....	22
Zygomatic breadth.....	91
Mastoid breadth.....	64
Greatest breadth of braincase above roots of zygomata.....	58
Least breadth of braincase immediately behind orbits.....	41
Orbital breadth.....	73
Least distance from orbit to alveolus of inner incisor.....	44
Greatest depth of braincase (exclusive of sagittal crest).....	49
Mandible.....	93
Greatest depth of ramus.....	20.5
Maxillary toothrow (exclusive of incisors).....	40
Mandibular toothrow (exclusive of incisors).....	43
Crown of middle upper molar.....	7.9×6.1
Crown of middle lower molar.....	8 ×5.3

Specimens examined.—Only the type.

CYNOMOLGUS CAGAYANUS, new species.

CAGAYAN SULU MACAQUE.

Type.—Adult male (skin and skull), Cat. No. 125325, U.S.N.M., collected on Cagayan Sulu Island, Sulu Sea (near Borneo), February 25, 1904, by Edgar A. Mearns. (Original number, 5771.)

Characters.—Size, the smallest of the Philippine Macaques; about three-fifths the bulk of *C. philippinensis* or *C. mindanensis*.

Color.—The fresh skin was put in alcohol, in which fluid it was shipped to the Museum. From my recollection I should say that its color is now considerably paler than when fresh. At present the upperparts are olive-brown, with scarcely a trace of chestnut or burnt umber on the head; sides of head brownish gray, face smoke gray; forehead grayish in front, behind which a crest of stiff black hair arises; underparts pale drab-gray; outer surface of limbs like the back above, but fading at the knee and elbow joints to drab-gray upon the forearms, hands, legs, and feet; tail above slate-black at base, fading to mouse gray toward the end, and drab-gray on the under side.

Skull and teeth.—The skull of the type is similar to that of the male of *C. mindanensis*, but is only as large as the female of that species, the proportion of weight in the sexes being as 9 to 15. The size would be, therefore, only three-fifths of that of *C. mindanensis*. In form the skull quite closely resembles that of *C. suluensis*; but the dentition is relatively much heavier. The audital bullæ are small, but inflated and prominent apically.

Cranial measurements of the type, an adult male, from Cagayan Sulu Island.

Measurement.	No. 125325, U.S.N.M., type.
	<i>mm.</i>
Greatest length (exclusive of incisors).....	110
Basal length.....	81
Basilar length.....	77
Least palatal length.....	46
Palatal breadth (between front molars).....	20.5
Zygomatic breadth.....	77
Mastoid breadth.....	60
Greatest breadth of braincase above roots of zygomata.....	55
Least breadth of braincase immediately behind orbits.....	38
Orbital breadth.....	59
Least distance from orbit to alveolus of inner incisor.....	41
Greatest depth of braincase (exclusive of sagittal crest).....	44
Mandible.....	81
Greatest depth of ramus.....	16
Maxillary toothrow (exclusive of incisors).....	39
Mandibular toothrow (exclusive of incisors).....	44.2
Crown of middle upper molar.....	7.9/7
Crown of middle lower molar.....	7.7/5.9
Upper canine from alveolus.....	20
Lower canine from alveolus.....	14

Specimens examined.—Only the type.

PTEROPUS LANENSIS, new species.

LAKE LANA O FRUIT-EATING BAT.

Kah-boog' (Moros of Pantar and Lake Lanao).

Type.—Adult male (skin and skull), Cat. No. 123291, U.S.N.M. Collected at Pantar (near Lake Lanao, altitude 1,907 feet), Mindanao, Philippine Islands, September 7, 1903, by Edgar A. Mearns. (Original number, 5626.)

Characters.—A member of the subgenus *Pteropus*, and similar to *Pteropus vampyrus* (Linnaeus) except in color. Ears long, and sharply pointed; thumb short compared with that of *P. vampyrus* from Java; and the tibia and forearm are less hairy above.

Membranes.—The uropatagium, as in *vampyrus*, is concealed by fur between the knee and body above, but only partially so below; propatagium naked above, furry below; wing membranes naked above, but furred below next to the body and along the border of the forearm.

Color.—Wing membranes blackish. Pelage black, above and below, faintly washed with seal brown on upper side of neck, and with burnt umber across shoulders and on rump. A few brownish-gray hairs are intermixed; but these are lacking on the chin, throat, under side of neck, and front of chest, where all of the hairs are black. Viewed in a certain light, the belly shows a tinge of seal brown. The pattern of the russet area of the neck of *vampyrus* is just perceptibly indicated above, but there is no trace of it on the under side of the neck.

Skull and teeth.—Similar to those of *P. vampyrus*.

Specimens examined.—Only the type.

Remarks.—Colonies of these large bats surrounded Lake Lanao, Mindanao, which occupies a basin 2,000 feet above the sea at water level of the lake, whence many of them regularly passed over our camp at Pantar, 5 miles distant, on the Agus River, which drains Lake Lanao. Several were shot and examined at Bacolod, on the northwest shore of the lake; but these specimens were lost in transportation during a military expedition. I do not remember that they varied from the type.

Cranial measurements of the type, an adult male, from Pantar, Mindanao.

Measurement.	No. 123291, U.S.N.M., type.
	<i>mm.</i>
Greatest length.....	76
Basal length.....	74
Basilar length.....	72
Median palatal length.....	43
Palatal breadth (between anterior molars).....	12.7
Zygomatic breadth.....	43.5
Least interorbital breadth in front of postorbital processes.....	10.2
Least interorbital breadth behind postorbital processes.....	9
Breadth between tips of postorbital processes.....	34.9
Greatest breadth of braincase above roots of zygomata.....	25.3
Greatest depth of braincase (exclusive of sagittal crest).....	19
Occipital depth.....	15
Greatest depth of rostrum at middle of diastema.....	11.5
Greatest breadth of rostrum at middle of diastema.....	13
Mandible.....	62
Maxillary toothrow (exclusive of incisors).....	29
Mandibular toothrow (exclusive of incisors).....	33
Crown of first upper molar.....	5.6
Crown of first lower molar.....	5

External measurements of adult male from Pantar, Mindanao.

Measurement (taken from fresh specimen).	No. 123291, U.S.N.M., type.
	<i>mm.</i>
Head and body.....	350
Alar expanse.....	1385
Distance from tip of nose to end of outstretched hind limb.....	500
Head.....	89
Thumb with its claw.....	69
Thumb without claw.....	55
Longest finger.....	370
Tibia.....	90
Foot.....	65
Calcaneal.....	30
Ear from meatus.....	36
Ear from crown.....	33
Width of ear.....	18

PTEROPUS CAGAYANUS, new species.

CAGAYAN SULU FRUIT-EATING BAT.

Type.—Adult male (skin and skull), Cat. No. 125289, U.S.N.M. Collected on Cagayan Sulu Island, near the west side of the Sulu Sea, Philippine Islands, February 25, 1904, by Edgar A. Mearns. (Original number, 5755.)

Characters.—A member of the subgenus *Spectrum* as defined by Matschie. Similar to *Pteropus hypomelanus* Temminck, but different in color; skull with osseous orbital ring complete in old individuals; teeth smaller than in *P. hypomelanus*.

Color.—The skins were temporarily preserved in formalin, but the colors have not been materially changed. Head blackish brown all round but slightly paler on crown, with a few whitish hairs intermixed above; upper side of neck and shoulders wood brown, becoming tinged with tawny posteriorly, where it ends abruptly in a straight transverse line; remainder of upperparts grizzled blackish. Under side of body russet brown, becoming blackish brown on the sides; feet and wing-membranes blackish.

Skull and teeth.—Save in the type, which is younger, all of the specimens have the postorbital and jugal processes united, completing the osseous orbit of the eye. Except in this respect, the skull closely resembles that of *P. hypomelanus* from the Natuna Islands, but the latter has the teeth slightly more robust. The same is true of *P. lepidus*. The skull and teeth of *P. cagayanus* are decidedly smaller than in Steere's specimens from Panay, which he called "*Pteropus hypomelanus*."

Cranial measurements of the type, an adult male, from Cagayan Sulu Island.

Measurement.	No. 125289, U.S.N.M., type.
	<i>mm.</i>
Greatest length.....	63
Basal length.....	61.5
Basilar length.....	59.5
Median palatal length.....	37
Palatal breadth (between anterior molars).....	11.3
Zygomatic breadth.....	35
Least interorbital breadth in front of postorbital processes.....	8.2
Least interorbital breadth behind postorbital processes.....	6.2
Breadth between tips of postorbital processes.....	26.5
Greatest breadth of braincase above roots of zygomata.....	22.5
Greatest depth of braincase.....	18
Occipital depth.....	13
Greatest depth of rostrum at middle of diastema.....	9
Greatest breadth of rostrum at middle of diastema.....	11.6
Mandible.....	52
Maxillary toothrow (exclusive of incisors).....	24
Mandibular toothrow (exclusive of incisors).....	27.5
Crown of first upper molar.....	5
Crown of first lower molar.....	4.3

External measurements of well-made skin.

Measurement.	No. 125289, U.S.N.M., type.
	<i>mm.</i>
Head and body.....	230
Tibia.....	64
Foot.....	45
Calcaneus.....	15
Forearm.....	138
Thumb with claw.....	53
Second (longest) digit.....	250
Ear from meatus.....	21
Ear from crown.....	17.5
Width of ear.....	16

Specimens examined. Three (skins and skulls), all found clinging to midrib of cocoanut-tree leaves, on Cagayan Sulu Island, Philippine Islands, near the west side of the Sulu Sea, February 25, 1904.

UROGALE, new genus.

ROUND-TAILED TUPAIAS.

Type.—*Urogale cylindrura*, new species.

Characters.—Size large; feet and claws relatively large; tail short-haired and cylindrical. Braincase narrow and elongate; zygomatic vacuities obsolete; rostrum produced, enlarged, and greatly swollen for the accommodation of enormous second incisors; second upper incisor caniniform; third lower incisor minute and erect; lower canines enormous.

UROGALE CYLINDRURA, new species.

MOUNT APO ROUND-TAILED TUPAIA.

Tahr'-rah Bah'-boo-ey (Bagobo name, meaning Ground-Pig).

Type.—Adult male (skin and skull), Cat. No. 125287, U.S.N.M. Collected on Mount Apo at the Bagobo village of Todaya, altitude 4,000 feet, southern Mindanao, Philippine Islands, July 12, 1904, by Edgar A. Mearns. (Original number, 5727.)

Characters.—Those of the genus. Similar to *Urogale everetti* (Thomas), but slightly larger and darker and different in color.

Color.—Entire upperparts blackish seal brown, variegated by minute tawny-ochraceous annuli to the hairs; a very indistinct ferruginous stripe over each shoulder; underparts broadly tawny-ochraceous in the median line, this color gradually merging into that of the upperparts; feet clove brown; tail colored like the back above, largely mixed with ferruginous below; naked skin of ears, surrounding eyes, snout, and under surface of feet dusky purplish; iris dark brown.

Skull and teeth.—Skull flattened above, and straight, backward to the junction of the parietal ridges, then sharply decurved posteriorly; orbital ring slender posteriorly; occipital crest and ridges very prominent; braincase and postpalatal notch narrow; teeth as in *Urogale everetti* (Thomas).

Cranial measurements of two adult males (type and topotype) from Mindanao, and of the type of Urogale everetti (Thomas).

Measurement.	<i>Urogale cylindrica</i> .		<i>Urogale everetti</i> (Thomas), type.
	No. 125287, U. S. N. M., type.	No. 125288, U. S. N. M., topotype.	
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Basilar length.....	56	54	54
Occipito-nasal length.....	63.5	61	64.5
Greatest breadth of skull.....	29.5	29	29
Nasal tip to front edge of orbit.....	31	29	30.7
Interorbital breadth.....	16.4	15.7	17.5
Intertemporal breadth.....	21	20.5	18
Palatal length.....	35	32.5	34
Palatal breadth.....	17	17	16
Palatal breadth, inside.....	9.9	9.5	8.2
Distance from front of first upper incisor to back of third upper molar.....	34	32.5	33.3
Diastema between second upper incisor and canine.....	4.8	4.2	4.4
Diastema between canine and the most anterior premolar.....	1.4	1.2	.9
Second upper incisor, height above bone behind.....	4.8	5	4.8
Second upper incisor, anteroposterior diameter at base.....	2.5	2.5	2.7
Upper canine, height.....	3	3	3
Upper canine, diameter.....	2	1.9	1.7
Third lower incisor, diameter.....	.5		.6
Third lower incisor, height.....	1.4		1.5
Lower canine, height.....	5.4	5.4	5.7
Lower canine, diameter.....	2.6	2.6	2.5
Combined lengths of three upper molars.....	10	9.8	10.6
Combined lengths of three lower molars.....		10.2	10.8

External measurements of two adult males from Mindanao.

Measurement (from fresh specimens).	No. 125287, U. S. N. M., type.	No. 125288, U. S. N. M., topotype.
	<i>mm.</i>	<i>mm.</i>
Total length.....	363	360
Tail vertebrae.....	163	155
Tail to end of hairs.....	182	185
Hind foot.....	54	51
Length of head.....	74	68
Height of ear above crown.....	11	9.5
Ear above notch at base.....	21	18
From tip of nose to angle of mouth.....	37	35
From tip of nose to eye.....	40	36
From tip of nose to ear.....	61	58

Specimens examined.—The type and one topotype.

Remarks.—The only ones seen were two that the Todaya Bagobos brought in to me alive. They called it *Tahr'-rah Bah'-boo-ey*, meaning Ground-Pig. At Tagulaya, on the shore of the Gulf of Davao, the Bagobos called it *Koh-lagh-chew'-ey*, saying that it is common in the mountains, but not found in the low country by the sea.

PODOGYMNURA, new genus.

LONG-LEGGED WOODSHREWS.

Type.—*Podogymnura truei*, new species.

Characters.—Related to *Gymnura* and *Hylomys*. Dental formula:
i. $\frac{3-3}{3-3}$, c. $\frac{1-1}{1-1}$, pm. $\frac{3-3}{3-3}$, m. $\frac{3-3}{3-3}$, = 40 teeth; second incisor the

smallest; tail robust and moderately hairy, more than one-third the length of head and body; hind foot seminaked, three-fourths the length of head; whiskers long, reaching shoulders; diameter of eye one-sixteenth the length of head; head less than one-fourth of total length; ears large, seminaked, height from meatus more than one-third the length of head; fore foot seminaked above, entirely so below, with four tubercles, one at the base of the second digit, one at the base of the fifth, a large vase-shaped one at the junction of the third and fourth, and a very prominent one at the base of the palm; hind foot 5-tuberculate, a small one at the base of the first digit, a large one at the base of the second, a vase-shaped one at the junction of the third and fourth, a medium-sized one at the base of the fifth, and a prominent one about midway between the heel and middle digits toward the inner side. Pelage long, full, and soft, with fur of different lengths.

PODOGYMNURA TRUEI, new species.

LONG-FOOTED WOODSHREW.

Tah'-rah Bah'-boo-ey (Bagobo).

Type.—Adult female (skull, with remainder in alcohol), Cat. No. 125286, U.S.N.M. Collected on Mount Apo at 6,000 feet altitude, southern Mindanao, Philippine Islands, June 25, 1904, by Edgar A. Mearns. (Original number, 5667.)

Characters.—Those of the genus.

Color (from fresh specimen).—Nose, toes, and claws flesh color; snout, lips, ears, tail, and feet purplish flesh color; pelage of upperparts slate-gray mixed with coarse reddish-brown hairs; underparts hoary, slightly mixed with brown hairs; claws horn color, with a reddish-brown spot at middle.

Skull and teeth.—Compared with *Hylomys suillus* Müller and Schlegel, the rostrum is more elongate, and the lower border of maxilla straighter (less arched); narial opening more oblique, sloping backward; nasal bones narrower; ramus of mandible much broader; first upper incisor largest, much smaller than canine; second upper incisor smallest; first upper premolar larger than second or third incisor, unicuspidate, and canine-like; second upper premolar apparently 2-rooted and flattened, with a prominent cingulum; third upper premolar externally similar to second, but with more prominent cingulum, and with the addition of a broad inner step with two tubercles, giving the tooth a quadrilateral form and molariform appearance; first and second upper molars quadrilateral, with four prominent cusps, one at each angle, and a minute central tubercle; third molar smaller, triangular, having three prominent cusps, one at each angle, and an antero-external step. In the mandible the incisors, as in

Gymnura, are progressively smaller from before backwards, with laterally expanded cusps, very different from those in the upper jaw; single-rooted lower canines much smaller than upper; lower pre-molars flattened, apparently 2-rooted, cingula prominent; molars decreasing in size from before backward, essentially 4-cuspidate.

This species is named in honor of Dr. Frederick W. True, head curator of the department of biology in the U. S. National Museum.

Cranial measurements of the type, an adult female, from southern Mindanao.

Measurement.	No. 125286, U.S.N.M., type.
	mm.
Zygo-matic breadth (about) <i>a</i>	18
Least interorbital breadth.....	9
Median length of palate.....	21
Length of internasal suture.....	13.6
Greatest length of nasal bone.....	15.1
Greatest breadth of nasals.....	2.5
Height of narial opening.....	4.9
Breadth of narial opening.....	3.5
Breadth of palate between anterior molars.....	5
Greatest breadth of palate outside of teeth.....	10.3
Diastema between first upper incisors.....	2
Distance between outer border of first upper incisors.....	3.3
Between upper canines.....	4.1
Between outer border of upper canines.....	6.1
From anterior border of first upper incisor to posterior margin of last molar.....	20
From anterior border of upper canine to posterior margin of last molar.....	15
From anterior border of first upper incisor to canine.....	5
United lengths of three upper molars.....	6.5
Length of first upper molar.....	2.5
Breadth of first upper molar.....	2.6
Length of first upper incisor from alveolus.....	2.3
Length of first upper canine from alveolus.....	3.1
From anterior border of first lower incisor to posterior border of last lower molar.....	18
Combined lengths of three lower molars.....	7.5
First lower molar.....	3×1.8

a Braincase of type and only specimen smashed by trap.

External measurements of the type, an adult female, from southern Mindanao.

[Taken from fresh specimen.]

Measurement.	No. 125286, U.S.N.M., type.
	mm.
Total length.....	210
Tail vertebrae.....	62
Hind foot.....	36
Fore foot.....	23.5
Head (about).....	49
Ear from crown.....	13
Ear from notch at base.....	19
From tip of nose to eye.....	26.5
From tip of nose to angle of mouth.....	17.5
From tip of nose to ear.....	32
Diameter of eye.....	3
Tibial joint.....	33
Forearm.....	25

MUS TAGULAYENSIS, new species.

TAGULAYAN WHITE-TAILED RAT.

Ahm'-bough (Visayans of Baganga).*Umb'-boh Tah-koo'-bung* (Bagobos of Tagulaya).

Type.—Adult male (skin and skull), Cat. No. 125264, U.S.N.M. Collected from sea-level, at Tagulaya, on the Gulf of Davao at the foot of Mount Apo, southern Mindanao, Philippine Islands, July 15, 1904, by Edgar A. Mearns. (Original number, 5732.)

Characters.—A member of the *Mus xanthurus* group, resembling *Mus everetti* Günther and *M. luzonicus* Thomas, but larger, and otherwise different from either. Tail white on terminal half, nearly naked, with short, stiff hairs between the verticelli; caudal annuli ten to the centimeter; ears nearly naked; pelage of upperparts mixed throughout with spiny hairs.

Color.—Upperparts yellowish brown (general effect raw umber), the pelage gray at base except for a mixture of whitish spines, darkest in the vertebral area; sides drab-gray, slightly mixed with raw umber tips to some of the hairs; underparts drab-gray, strongly washed with cinnamon and isabella color on the throat, chest, inner aspect of limbs, and genitals; feet bistre above, with grayish-white tufts at base of nails; claws flesh color tipped with horn color; ears dark drab, fleshy within; tail purplish black all round on basal half, whitish on terminal half.

Skull and teeth.—Resembling those of *Mus xanthurus* J. E. Gray.

Specimens examined.—Two, the type, and Cat. No. 125266, U.S.N.M., from the Baganga River, southeastern Mindanao, April 30, 1904, collected by the author.

Cranial measurements of the type, an adult male, from Mindanao.

Measurement.	No. 125264, U.S.N.M., type.
Basilar length (Hensel)	44
Occipito-nasal length	54
Interparietal breadth (from outer edge of beaded upper margins)	17.2
Length of internasal suture	21
Greatest breadth of rostrum	9.6
Length of upper toothrow	10.1

External measurements, the type.

Measurement (from fresh specimen).	No. 125264, U.S.N.M., type.
	mm.
Total length.....	522
Tail vertebrae.....	260
Tail to end of hairs.....	264
Hind foot.....	52
Head.....	64
Ear above crown.....	23
Ear above notch.....	28
Longest whiskers.....	88

Comparative measurements of three species of the Mus xanthurus group.

	Type of <i>Mus ever-</i> <i>etti</i> .	Type (No. 125264) of <i>Mus tagu-</i> <i>layensis</i> .	Type (No. 125258) of <i>Mus albigu-</i> <i>laris</i> .
	mm.	mm.	mm.
Length of head and body.....	216	262	260
Length of tail.....	188	260	236
Length of fore foot.....	25.40	26.40	27
Length of hind foot.....	48.80	52	52
Length of a long hair on back.....	42.32	42	65
Length of skull.....	50.80	54	54
Length of series of upper molars.....	9.17	10.10	10.2
Length of first upper molar.....	4.23	4.20	4.50
Distance between incisors and first molar.....	14.11	14.50	14

MUS ALBIGULARIS, new species.**WHITE-THROATED WHITE-TAILED RAT.**

Oom-bough' Kah-wee'-lee (Bagobos of Todaya on Mount Apo).

Type.—Adult male (skin and skull), Cat. No. 125258, U.S.N.M. Collected on Mount Apo at 7,600 feet altitude, southern Mindanao, Philippine Islands, July 3, 1904, by Edgar A. Mearns. (Original number, 5699.)

Characters.—Pelage softer, longer, and much denser than that of *Mus xanthurus* J. E. Gray and *M. everetti* Günther, with much fewer spines; terminal two-thirds of tail whitish; size smaller than *M. xanthurus*, with ears relatively smaller. Mammaræ 4 pairs—2 pectoral and 2 inguinal.

Color.—Upperparts yellowish brown (general effect mummy brown), the pelage slate-gray at base except for a mixture of whitish spines, darkest in the vertebral area; sides drab-gray, strongly mixed with raw umber, with which many of the hairs are tipped; underparts white; feet mouse gray, with toes grizzled white, and claws horn color; ears drab-gray, fleshy within. The young are mouse gray above, white below, with more or less brown and russet colors added to the upperparts with increasing age.

Skull and teeth.—Closely resembling those of *Mus xanthurus*. The teeth are not quite so simple as those of the *Mus rattus* group, there

being a tendency to the development of extra tubercles or enamel loops on the outer border of both upper and lower molars; but these subsidiary supernumerary cusps lack uniformity, and are frequently wanting; audital bullæ prominent, indented externally.

Cranial measurements of the type, an adult male, from Mindanao.

Measurement.	No. 125258, U.S.N.M., type.
Basilar length (Hensel)	mm. 45
Occipito-nasal length	54
Interparietal breadth (from outer edge of beaded upper margins)	16
Length of internasal suture	20
Greatest breadth of rostrum	9.8
Length of upper molar series	10.2

External measurements of nine specimens from Mount Apo, southern Mindanao.

Measurement (taken fresh).	No. 125238, U.S.N.M., male type.	No. 125255, U.S.N.M., male topotype.	No. 125260, U.S.N.M., male.	No. 125254, U.S.N.M., female.	No. 125257, U.S.N.M., female.	No. 125259, U.S.N.M., female.	No. 125261, U.S.N.M., female.	No. 125262, U.S.N.M., female.	No. 125263, U.S.N.M., female.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total length	496	490	517	480	425	450	481	500	488
Tail vertebrae	236	242	260	245	210	225	250	255	248
Tail to end of hairs	240	247	263	248	213	228	254	258	250
Hind foot	52	52	54	49	46	47	49	50	50
Head	64	67	65	62	60	63	63	64	64
Ear above crown	17	18	20	18	19	19	18	18	19
Ear above notch	24	24	25	22	25	26	23	23	25
White portion of tail	153	125		125	123				

Remark.—A female, Cat. No. 125263, U.S.N.M., contained 2 foetuses, July 9, 1904; another, 2 large foetuses, July 3.

Specimens examined.—Eighteen, 17 skins with skulls and 1 in alcohol, all from Mount Apo, at 6,750 to 7,900 feet altitude, June 26 to July 9, 1904. Their stomachs were usually filled with fruit, largely mixed with insects.

MUS MAGNIROSTRIS, new species.

PHILIPPINE GRAY RAT.

Ahn-bough' (Moros of Zamboanga).

Type.—Adult female (skin and skull), Cat. No. 125212, U.S.N.M. Collected at Zamboanga (old Spanish hospital), western Mindanao, Philippine Islands, January 15, 1904, by Edgar A. Mearns. (Original number, 5639.)

Characters.—A member of the *norvegicus* group, resembling *Mus norvegicus* Erxleben in general external appearance, but with a longer

tail, larger ears, and an admixture of grooved spines in the pelage of the upper surface. Eight caudal annuli to the centimeter on middle of tail (two less than in Scandinavian specimens of *Mus norvegicus*); longest whiskers reaching beyond tips of extended ears.

Color.—Like that of the gray rat of Norway, but with pelage less dense, and perhaps a trifle paler.

Skull and teeth.—Skull heavily ossified; temporal fossa smooth; braincase smooth and flattened above, the region included between the supraorbital beads narrow and triangular as in *Mus norvegicus*; anteorbital region broad and elevated; rostrum greatly thickened; nasals broad, obtusely pointed posteriorly, ending opposite fronto-maxillary suture; audital bullæ flattened and broadened; teeth similar to those of *M. norvegicus*.

Cranial measurements of the type, an adult female, from Zamboanga, Mindanao.

Measurement.	No. 125212, U.S.N.M., type.
	<i>mm.</i>
Basilar length (Hensel)	39
Occipito-nasal length	46
Interparietal breadth (from outer edge of beaded upper margins)	13
Length of internasal suture	18
Greatest width of rostrum	9.3
Length of upper toothrow	7.5

External measurements of the type and of an adult male from Zamboanga, Mindanao.

[Taken from fresh specimen.]

Measurement.	No. 125212, U.S.N.M., type.	No. 125211, U.S.N.M.
	<i>mm.</i>	<i>mm.</i>
Length	404	420
Tail vertebrae	195	201
Hind foot	42	43
Head	53	56.5
Ear above crown	18	18
Ear above notch	22	21.5
Tail to end of hairs	199	.....

Specimens examined.—The type and one topotype.

MUS MINDANENSIS, new species.

MINDANAO SPINY RAT.

Rec'-ah (Moros of Pantar).

Umb'-bough Hah-wee'-lee (Bagobos of Todaya).

Type.—Adult male (skin and skull), Cat. No. 125274, U.S.N.M. Collected at Todaya, altitude 4,000 feet, Mount Apo, southern Mindanao, July 9, 1904, by Edgar A. Mearns. (Original number. 5719.)

Characters.—A large member of the *rattus* group. Whiskers reaching to shoulders; tail concolor; upper pelage quite thickly mixed

with flattened, channelled spines; caudal annuli, eight to the centimeter, at middle of tail.

Color.—General color of upperparts cinnamon-russet, more grayish brown on the head, everywhere coarsely mixed with black; underparts whitish drab-gray, washed with cinnamon in the pectoral region and along the sides; fore and hind feet whitish drab, usually with a darker area over the middle metatarsals—sometimes as dark as mouse gray. Tail concolor, mouse gray or browner. Young, drab-gray above, whitish smoke gray below.

Skull and teeth.—Braincase wide and arched; temporal fossa ridged; audital bullæ high and rounded. Teeth not peculiar.

Cranial measurements of the type, an adult male, from Todaya, Mindanao.

Measurement.	No. 125274, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	39
Occipito-nasal length.....	47.5
Interparietal breadth (from outer edge of beaded upper margins).....	16
Length of internasal suture.....	17
Greatest breadth of rostrum.....	9
Length of upper tooththrow.....	8

External measurements of the type, an adult male, from Todaya and of adult female from Pantar, Mindanao.

Measurement (from fresh specimens).	No. 125274, U.S.N.M., type.	No. 123292, U.S.N.M.
	mm.	mm.
Length.....	420	410
Tail to end of vertebrae.....	215	207
Tail to end of hairs.....	220	211
Hind foot.....	44	40
Head.....	55	53
Ear above crown.....	19	18
Ear above notch.....	23	24

Specimens examined.—Ten: three from sea-level, at Davao, Mindanao; five from Pantar, Mindanao (altitude 1,907 feet); and two from Todaya (altitude 4,000 feet), on Mount Apo, Mindanao.

MUS ZAMBOANGÆ, new species.

ZAMBOANGA SPINY-HAIRED RAT.

Type.—Adult male (skin and skull), Cat. No. 125279, U.S.N.M. Collected at Zamboanga, western Mindanao, Philippine Islands, January 20, 1904, by Edgar A. Mearns. (Original number, 5753.)

Characters.—A member of the *rattus-alexandrinus* group. Pelage of upperparts coarse and spiny, of feet and underparts short, fine, and soft, whiskers long, reaching the shoulders; caudal annuli, 11 to the centimeter, on middle of tail; tail concolor, longer than head and body; ears medium-sized, nearly naked except on edges.

Color.—Upperparts cinnamon-russet, mixed with gray and black; sides bordered by clear cinnamon; underparts pale drab-gray; feet whitish drab, with a stripe of hair brown on upper surface; tail grayish brown; whiskers black; anterior face of incisor teeth ochraceous.

Skull and teeth.—Skull small, narrow, with a short and narrow rostrum, braincase convex above, and with supraorbital bead bending evenly outward posteriorly, without a marked prominence at the outer extremity of the fronto-parietal suture; zygomatic arches very slender; temporal fossa ridged; audital bullæ small, very narrow, and rather high; dentition weak.

Specimens examined.—Only the type.

Cranial measurements of the type, an adult male, from Zamboanga, Mindanao.

Measurement.	No. 125279, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	32
Occipito-nasal length.....	38.5
Interparietal breadth (from outer edge of beaded upper margins).....	13.6
Length of internasal suture.....	12.5
Greatest width of rostrum.....	7
Length of upper toothrow.....	6.7

External measurements (from well-made skin).

Measurement.	No. 125279, U.S.N.M., type.
	mm.
Total length.....	315
Tail vertebrae.....	165
Tail to end of hairs.....	167
Hind foot.....	36
Height of ear above crown.....	15

MUS KELLERI, new species.

DAVAO SOFT-HAIRED RAT.

Type.—Adult female (skin and skull), Cat. No. 125278, U.S.N.M. Collected at Davao, southern Mindanao, Philippine Islands, July 20, 1904, by Edgar A. Mearns. (Original number, 5738.)

Characters.—Apparently a member of the *rattus-alexandrinus* group, but without spiny hairs in the pelage; whiskers extending beyond the tips of ears; caudal annuli 10 to the centimeter on middle of tail; tail concolor, longer than head and body; ears large, scantily haired. Mammaræ 4 pairs: 2 thoracic, 1 abdominal, and 1 inguinal.

Color.—Similar to *Mus mindanensis* (see page 442), but darker and more reddish above. Upperparts mars brown, thickly mixed with black; underparts yellowish white; nose sepia; forearm hair brown; feet white with a band of hair brown above, narrow on the hind feet, extending to the base of the toes; tail grayish brown.

Skull and teeth.—Skull similar to that of *Mus mindanensis*, but higher in the parietal region, with nasals and rostrum narrower, and with audital bullæ smaller and much narrower. Teeth not peculiar.

Specimens examined.—Only the type.

This species is named in honor of Mr. Fletcher L. Keller, of Davao, Mindanao.

Cranial measurements of the type, an adult female, from Davao, Mindanao.

Measurement.	No. 125278, U.S.N.M., type.
	mm.
Basilar length (Hensel)	33.5
Occipito-nasal length	41
Interparietal breadth (from outer edge of beaded upper margins)	13.7
Length of internasal suture	14
Greatest breadth of rostrum	7
Length of upper toothrow	7.5

External measurements of the type.

Measurement (taken from fresh specimen).	No. 125278, U.S.N.M., type.
	mm.
Length	375
Tail vertebrae	198
Tail to end of hairs	202
Hind foot	40
Head	50
Ear above crown	18.5
Ear above notch	22

MUS TODAYENSIS, new species.

TODAYAN RAT.

Oomb'-bough Tahr-ree-ahn' (Bagobos of Todaya, Mount Apo).

Type.—Adult female (skin and skull), Cat. No. 125224, U.S.N.M. Collected at Todaya, altitude 4,000 feet, on Mount Apo, southern Mindanao, Philippine Islands, July 11, 1904, by Edgar A. Mearns. (Original number, 5722.)

Characters.—Size small; pelage very spiny; ears rather large, nearly naked; tail concolor, finely haired, with annuli (numbering 12 to the centimeter) plainly visible; whiskers extending beyond the tips of the ears; tail about equaling the length of the head and body. Its general appearance suggests the rats of the *Mus surdus* group, which are, however, much more spiny.

Color.—Upperparts tawny-olive, finely mixed with black in the vertebral area, and with broccoli brown on the sides; underparts grayish white perceptibly washed with cinnamon; ears and tail purplish gray-brown; feet pale drab-gray, with a stripe of sepia on upper surface.

Skull and teeth. Skull high, with braincase expanded in the parietal and contracted in the frontal region; supraorbital bead prominent; temporal fossa ridged; rostrum stout; nasals narrowed and bluntly pointed posteriorly; audital bullae high and elongate; post-palatal notch wide; anterior surface of upper incisors ochraceous.

Cranial measurements of the type, an adult female, from Todaya, Mindanao.

Measurement.	No. 125224, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	27
Occipito-nasal length.....	34
Interparietal breadth (from outer edge of beaded upper margins).....	13
Length of internasal suture.....	13
Greatest breadth of rostrum.....	6
Length of upper toothrow.....	5.9

External measurements of five adult specimens from Todaya, Mindanao.

Measurement (taken fresh).	No. 125224, U.S.N.M., type. ^a	No. 125223, U.S.N.M., topotype. ^a	No. 125225, U.S.N.M., topotype. ^b	No. 125226, U.S.N.M., topotype. ^b	No. 125227, U.S.N.M., topotype. ^b
	mm.	mm.	mm.	mm.	mm.
Total length.....	283	278	291	285	285
Tail vertebra.....	145	144	138	130	130
Tail to end of hairs.....	148	148	143	133	133
Hind foot.....	29	27	30	28.5	28
Head.....	42	39	43	42	42
Ear above crown.....	13	13	13	13	13
Ear above notch.....	18	18	18	18	18

^a Adult female.

^b Adult male.

Specimens examined.—Five adults, all from Todaya, on Mount Apo, altitude 4,000 feet. Skins with skulls.

MUS VULCANI, new species.

APO VOLCANO RAT.

Oom'-bough Tahr-ree-ahn' (Bagobo).

Type.—Adult female (skin and skull), Cat. No. 125216, U.S.N.M. Collected on Mount Apo at 7,600 feet altitude, southern Mindanao, Philippine Islands, June 26, 1904, by Edgar A. Mearns. (Original number, 5674.)

Characters.—Similar to *Mus concolor* Blyth, but larger; also resembling *M. todayensis*, but smaller, darker, with less spiny hair. Tail not strictly unicolor, but paler on under side; whiskers reaching tip of ears; caudal annuli 10 to the centimeter on middle of tail; ears large, nearly naked; tail about equaling the length of the head and body, but frequently longer.

Color.—Central area of upperparts dusky chocolate; sides drab-gray overlaid by tawny-olive tips to the long hairs; muzzle hair brown; underparts whitish gray, perceptibly washed with cinnamon; tail

dusky drab above, drab-gray below; feet whitish drab, without a dusky stripe on upper side; ears drab; whiskers brownish black.

Skull and teeth.—Skull light, with prominent superciliary frontoparietal beads; braincase arched above; rostrum depressed; temporal fossa slightly ridged; nasal bones rather narrow, pointed posteriorly; audital bullæ high, narrow, and elongate. Teeth not peculiar.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125216, U.S.N.M., type.
	<i>mm.</i>
Basilar length (Hensel)	14.3
Occipito-nasal length	30
Interparietal breadth (from outer edge of beaded upper margins)	12.5
Length of internasal suture	11.5
Greatest width of rostrum	6
Length of upper toothrow	5.1

External measurements of the type and of an adult male from Mount Apo, Mindanao.

Measurement (from fresh specimens).	No. 125219, U.S.N.M.	No. 125216, U.S.N.M., type.
	<i>mm.</i>	<i>mm.</i>
Total length	258	225
Tail vertebrae	125	135
Tail to end of hairs	128	138
Hind foot	25.5	27
Head	35	36
Ear above crown	11	13
Ear above notch at base	a 14	18

a Ears probably abnormal.

Specimens examined.—Eight; 7 skins with skulls, and 1 in alcohol, all from Mount Apo, at 7,600 feet altitude.

MUS VULCANI APICIS, new subspecies.

APO SUMMIT RAT.

Type.—Adult female (skin and skull), Cat. No. 125229, U.S.N.M. Collected on the summit of Mount Apo, altitude about 9,700 feet, southern Mindanao, Philippine Islands, July 6, 1904, by Edgar A. Mearns. (Original number, 5709.)

Characters.—Resembling *Mus vulcani vulcani*, but differing in having a much fuller and softer, almost spineless, pelage; ears shorter; whiskers reaching tips of ears; caudal annuli thirteen to the centimeter on middle of tail.

Color.—Like *vulcani*, but darker above, and more whitish gray on the underparts, which lack the cinnamon wash.

Skull and teeth.—Like those of *vulcani*, but with shorter audital bullæ.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125229, U.S.N.M., type.
	<i>mm.</i>
Basilar length (Hensel)	24.9
Occipito-nasal length	30.1
Interparietal breadth (measured from the outer edge of beaded upper margins).....	12
Length of internasal suture.....	10.5
Greatest width of rostrum.....	5.3
Length of upper tooththrow.....	5.1

External measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement (taken from fresh specimen).	No. 125229 U.S.N.M., type.
	<i>mm.</i>
Total length.....	248
Tail vertebrae.....	120
Tail to end of pencil.....	123
Hind foot.....	26.5
Head.....	36
Ear from crown.....	12
Ear from notch at base.....	17

Specimens examined.—Only the type.

MUS PANTARENSIS, new species.**PANTAR RUSSET MOUSE.**

Ree'-ah (Moros of Pantar).

Type.—Adult female (skin and skull), Cat. No. 123294, U.S.N.M. Collected at Pantar, altitude 1,907 feet, Mindanao, Philippine Islands, September 4, 1903, by Edgar A. Mearns. (Original number, 5622.)

Characters.—Size small; tail concolor, as long as head and body, scantily coated with short, stiff hairs, with annuli numbering thirteen to the centimeter near base of tail; pelage short, thickly mixed with coarse, flattened and channeled spines; moderate-sized ears, nearly naked; whiskers short, not reaching tip of ear.

Color.—Upperparts russet, finely mixed with black; underparts grayish cream-buff; ears and tail pale drab; feet grayish white, with a stripe of sepia on upper surface; whiskers brownish black.

Skull and teeth.—Skull considerably arched in the parietal region; rostrum short and stout; audital bullæ short, broad, and high; temporal fossa ridged; nasal bones truncate posteriorly. Dentition weak, not otherwise peculiar.

Specimens examined.—Only the type.

Cranial measurements of the type, an adult female, from Pantar, Mindanao.

Measurement.	No. 123294, U. S. N. M., type.
	mm.
Basilar length (Hensel)	24.5
Occipito-nasal length	29
Interparietal breadth (from outer edge of beaded upper margins)	12.6
Length of internasal suture	10
Greatest breadth of rostrum	5
Length of upper toothrow	5.2

External measurements, the type.

Measurement (taken from fresh specimen).	No. 123294, U. S. N. M., type.
	mm.
Total length	250
Tail vertebrae	125
Tail to end of hairs	128
Hind foot	27
Head	36
Ear above crown	14
Ear above notch	18

MUS COMMISSARIUS, new species.

PHILIPPINE HOUSE-MOUSE.

Type.—Adult female (skin and skull), Cat. No. 125213, U.S.N.M. Collected in the military commissary building at Davao, southern Mindanao, Philippine Islands, July 19, 1904, by Edgar A. Mearns. (Original number, 573±.)

Characters.—Smaller than *Mus musculus* Linnaeus; color similar, but with underparts darker; whiskers not reaching tips of ears; tail bicolor.

Color.—Upperparts hair brown, strongly washed with raw umber; underparts drab, faintly washed with cinnamon; tail dusky brownish above, soiled grayish white below.

Skull and teeth.—Similar to *Mus musculus* but smaller, with relatively smaller audital bullæ; nasals ending obtusely, considerably in advance of the base of the premaxillaries, instead of acutely and even with the premaxillaries.

Specimens examined.—Two. The type, which contained two foetuses, and male topotype, Cat. No. 125214, U.S.N.M.

Cranial measurements of the type, an adult female, from Davao, Mindanao.

Measurement.	No. 125213, U. S. N. M., type.
	<i>mm.</i>
Basilar length (Hensel).....	15.5
Occipito-nasal length.....	19.5
Greatest parietal breadth.....	8.9
Greatest zygomatic breadth.....	10.2
Length of audital bullæ.....	3
Length of internasal suture.....	6.2
Length of upper toothrow.....	3.1

External measurements of the type.

Measurement (taken from fresh specimen).	No. 125213, U. S. N. M., type.
	<i>mm.</i>
Total length.....	167
Tail vertebra.....	83
Tail to end of hairs.....	85
Hind foot.....	17
Head.....	24
Ear above crown.....	11
Ear above notch.....	13.5

BULLIMUS, new genus.**BAGOBO RATS.**

Type.—*Bullimus bagobus*, new species.

Characters.—Similar to *Mus*, but with three additional subsidiary cusps to the lower molar series of either side, placed externally, one in front of the last series of cusps of the anterior molar, and one in front of each series of the middle molar; lower jaw with a projecting capsule for the accommodation of the base of the lower incisor tooth; audital bullæ collapsed and flattened externally so that the audital opening is compressed and directed posteriorly; skull elevated in the anteorbital region; rostrum elongate; fronto-parietal bead slightly marked, bony palate narrow (see measurements below). Size large; pelage coarse, containing a mixture of ordinarily coarse hair and slender spines on upper surface; whiskers long, reaching the shoulders.

BULLIMUS BAGOBUS, new species.**BAGOBO RAT.**

Omb-boi'-say Oom-bough' (Bagobo).

Type.—Adult female (skin and skull), Cat. No. 125248, U.S.N.M. Collected at Todaya, a Bagobo village at 4,000 feet altitude on Mount Apo, southern Mindanao, Philippine Islands, July 13, 1904, by Edgar A. Mearns. (Original number, 5729.)

Characters.—Those of the genus. Tail slightly palest below, scantily coated with fine short hairs which nowhere conceal the annuli, which number about nine to the centimeter.

Color.—Dorsal area, from forehead to rump, clove brown, many of the hairs tipped or ringed with tawny-olive, and with pelage slate color at base; sides hair brown, thickly mixed with tawny-olive rings and tips to the hairs, the pelage smoke gray at base; underparts yellowish white, with the gray basal portion of hair appearing copiously along the sides; feet sepia brown above, except the toes, which are dirty grayish white; claws flesh color at base tipped with horn color; whiskers black, slightly mixed with grayish-white ones; tail purplish brown above, perceptibly paler and faintly rufescent below.

Skull and teeth.—The molars are rooted as follows: Anterior upper molar 5-rooted; middle upper molar 4-rooted; posterior upper molar 2-rooted, the roots exhibiting a tendency to bifurcation.

Remark.—The unique specimen was snared by a native, who brought it and a fine specimen of *Mus mindanensis* to me on the trail as I was leaving the Bagobo village of Todaya.

Cranial measurements of the type, an adult female, from Todaya, Mindanao.

Measurement.	No. 125248, U.S.N.M., type.
	mm.
Basilar length (Hensel)	46
Occipito-nasal length	58
Greatest interparietal breadth	21.6
Interparietal breadth, measured from outer edge of fronto-parietal ridges	16.5
Zygomatic breadth	27
Length of internasal suture	23.3
Length of audital bulla	10
Width of audital bulla	7
Length of upper toothrow	10
Distance between anterior molars	4
Distance between posterior molars	4.6

External measurements of the type (from well-made skin).

Measurement.	No. 125248, U.S.N.M., type.
	mm.
Head and body	275
Scaly portion of tail (end apparently gone)	128
Hind foot	54
Longest whisker	76

LIMNOMYS, new genus.

MARSH-RATS.

Type.—*Limnomys sibuanus*, new species.

Characters.—Resembles *Mus*. Skull relatively broad and high, with flattened audital bullæ; supraorbital beading slight, becoming obsolete on front of parietals; teeth of type and only specimen too

worn to furnish characters distinguishing them from those of *Mus*, except that the incisors are relatively much narrower. Pelage long and dense, that of underparts resembling *Oryzomys*; tail hairy, especially near the end, where the annuli are concealed; ears moderate in size, coated on edge and outer surface with short hair; feet broad, with underside smooth and naked, with tubercles flattened, the sixth or postero-external one obsolete.

LIMNOMYS SIBUANUS, new species.

SIBUAN RIVER MARSH-RAT.

Type.—Adult female (skin and skull), Cat. No. 125228, U.S.N.M. Collected on Mount Apo at 6,600 feet altitude, southern Mindanao, Philippine Islands, June 30, 1904, by Edgar A. Mearns. (Original number, 5688.)

Characters.—Those of the genus. Tail concolor, with annuli sixteen to the centimeter at middle, and extreme base smooth and naked below; whiskers long, extending to the shoulders; belly so densely furred that the mammae can not be detected; longest hairs of rump, 35 mm. in length.

Color.—General color of upperparts raw umber, washed with tawny-olive on sides, darkest on middle area of upperparts, where the most black hairs are intermixed; entire underparts, except tail, cream-buff, washed with clay color on chest and around vent; tail grayish brown; upper surface of feet broadly banded with seal brown, with toes and sides of feet brownish white; nail-tufts grayish white; claws flesh color tipped with horn color; ears dark drab, with pale yellowish tufts of fur at anterior base; muzzle grayish drab; whiskers mixed black and white; pelage of upperparts gray (No. 6 Ridgway) at base, of underparts cream-buff to the base.

Remark.—The unique type was trapped on a wet, mossy growth of vegetation, on the left bank of a little stream which in its lower course becomes the Sibuan River, flowing from Mount Apo. In spite of persistent efforts we failed to procure other specimens.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125228, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	26
Occipito-nasal length.....	32
Interparietal breadth (between outer edge of upper parietal margins).....	14.5
Length of internasal suture.....	12
Greatest breadth of rostrum.....	5.5
Length of upper toothrow.....	5

External measurements of the type.

Measurement (taken from fresh specimen).	No. 125228, U.S.N.M., type.
	mm.
Total length.....	275
Tail vertebrae.....	150
Tail to end of hairs.....	153
Hind foot.....	30
Head.....	40
Ear above crown.....	15
Ear above notch.....	21
Diameter of eye.....	5.8

TARSOMYS, new genus.

TUBERCULATE-SOLED RATS.

Type.—*Tarsomys apoensis* new species.

Characters.—Related to *Mus*, *Apomys*, and *Batomys*. General external appearance similar to *Sigmodon*. Pelage long and rather coarse, but not spiny, with hair of two lengths, the overhair being about twice the length of the ordinary coat. Ear rather prominent, its height from crown nearly one-third the length of head; skin of ear roughened and coated on both surfaces with short, thick hairs. Whiskers long, surpassing the ears. Eyes of medium size. Feet naked below; fore feet 5-tuberculate; hind feet 6-tuberculate, those at base of inner and outer digits 2-lobed, and with several small additional tubercles. Tail hairy. Skull and teeth resembling those of *Batomys* Thomas, but relatively broader, with a more inflated braincase, and large vacuities above the auditory meatus. The lateral teeth are extremely oblique in their position, the upper being rotated outward and the lower correspondingly rotated inward. The anterior upper molar resembles that of *Mus*, differing in that the anterior series comprises but two cusps, a small inner and a large outer one.

TARSOMYS APOENSIS, new species.

APO TUBERCULATE-SOLED RAT.

Type.—Adult male (skull, with remainder in alcohol), Cat. No. 125280, U.S.N.M. Collected on Mount Apo at 6,750 feet altitude, southern Mindanao, Philippine Islands, July 5, 1904, by Edgar A. Mearns. (Original number, 5706.)

Characters.—Pelage coarse, longest on the rump, where the hairs of the general coat measure 20 mm. in length, the stiff black overhairs measuring 40 mm. The shorter hairs are tipped with yellowish brown, slightly grizzled. Palms and soles naked, but with a hairy tuft on inner side at base of heel and a few long hairs at outer border of wrist. The toes are tufted at base of claws, the hairs extending 3 mm.

beyond the tips of the claws. Fore foot 5-tuberculate; three small anterior tubercles forming a triangle, the front one placed at the junction of the third and fourth digits, the others, respectively, at the junction of the second and third and fourth and fifth digits, the outer one being slightly posterior. The two large palmar tubercles are aligned on the abortive thumb, which has a small, round, flattened nail. Hind foot with double-lobed tubercles at the base of the inner and outer digits, small rounded tubercles at the junction of the second and third and third and fourth digits, a small rounded one near the outer margin of the naked sole anteriorly, and an elongated one near the inner margin posteriorly. There are also several additional tubercles of minute size, notably one or two behind the postero-external one. The tail is concolor, quite thickly coated with stiff brownish-black hairs which obscure the annuli, which latter number thirteen to the centimeter on the middle of the tail.

Color.—Upperparts brownish slate, enlivened by yellowish-brown tips to the hairs of the general coat; muzzle blackish; underparts grizzled yellowish brown; tail dark purplish brown throughout; feet well coated above with hairs which are drab-brown, slightly grizzled; ears dark purplish brown, coated with blackish hairs; whiskers blackish, with a few grayish white ones; pelage of upperparts slate colored at base, paler at base on underparts.

Skull and teeth.—In the general shape of the skull there is a resemblance to *Apomys*, the swollen braincase, lengthened rostrum, and upper profile being similar; but the audital bullæ, anterior palatine foramen, and teeth are very different. In the form of the rostrum and nasals and the length of the anterior palatine foramen, as well as the general configuration, there is a similarity to *Batomys*, which is strengthened by an external resemblance. The teeth are similar to those of *Mus*; but the audital bullæ are more flattened and compressed externally and the palate much broader. The skull is light, with a large semicircular vacuity between the temporal and parietal bones, above the auditory opening. Rostrum elongate; nasals narrow, truncate posteriorly.

Specimens examined.—Only the type.

Cranial measurements of the type, an adult male, from Mount Apo, Mindanao.

Measurement.	No. 125280, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	28.5
Occipito-nasal length.....	37.5
Greatest interparietal breadth.....	16
Least interorbital breadth.....	6
Length of internasal suture.....	15.2
Breadth of palate between last molars.....	5.1
Antero-posterior diameter of audital bullæ.....	6.2
Length of upper tooththrow.....	6.2
Mandible.....	21
Length of mandibular tooththrow.....	6.2

External measurements, the type.

Measurement (taken from fresh specimen).	No. 125280, U.S.N.M., type.
Total length.....	mm. 255
Tail vertebrae.....	120
Tail to end of hairs.....	124
Fore foot.....	16 x 5.5
Hind foot.....	32 x 8
Head.....	45
Ear from crown.....	14
Ear above notch at base.....	20
Longest whisker.....	42
Diameter of thickest part of tail.....	5.5

APOMYS, new genus.

MOUNT APO MICE.

Type.—*Apomys hyllocetes*, new species.

In general, *Apomys* is a connectant of the genera *Mus* and *Peromyscus*. The shape of the pterygoids and postpalatal notch closely resembles those of the genus *Chiropodomys*. The teeth and character of pelage are not unlike those of *Malacomys*, with the exception of the posterior upper molar, which is much smaller and less complex in *Apomys*. The braincase resembles that of *Peromyscus* and *Cricetulus*, but is more swollen in the parietal region.

Characters.—General external form as in *Mus*; pollex slightly less rudimentary, with a rather broad nail; soles naked; fore foot with 5 tubercles, 4 of which are placed at the base of the digits, the fifth at the outer side of the base of the palm, the two posterior tubercles being relatively much larger than in *Mus*; hind foot with 6 tubercles, 1 at the base of the first (inner) toe, 1 at the base of the second, 1 at the junction of the third and fourth, 1 at the base of the fifth, a small rounded one on the outer side of the sole a little behind the first digital tubercle, and an elongated one occupying the inner margin of the sole;^a eyes relatively smaller than in *Mus*; whiskers very long, reaching to the abdomen; body thickly furred above and below, with pelage long and soft; ears large, thin, and naked; tail scantily haired, longer than head and body, sometimes white at the end, the annuli distinctly visible; mammae, two pairs, inguinal. In eight females examined no thoracic or abdominal mammae were detected. Skull elongate, with a pronounced rostral portion; without superciliary bead; incisive foramen less than half the length of diastema between incisor and lateral teeth; upper and lower incisors yellow on anterior face, and without groove; molars rooted; first upper molar 6-tuberculate, in three series,

^a The tubercles of the hind foot are not paired as they are in *Mus*, but are more widely separated and oblique to each other. In *Mus* the outer tubercle of the middle pair is internal to the base of the outer digit, while in *Apomys* it is marginally placed at the base of the digit.

with three primary and three subsidiary cusps, the anterior series comprising one large anterior tubercle and one small postero-internal tubercle; middle series comprising one large median and two postero-lateral subsidiary tubercles, one large posterior tubercle having an internal ledge. Middle upper molar with two large and three subsidiary tubercles, a large anterior tubercle with a prominent antero-internal and two small lateral tubercles, and a single large posterior tubercle joined to the antero-lateral tubercles by low lateral ridges, the external one obsolete. Third upper molar small, its crown a roughened tubercle with a minute antero-internal groove and tubercle. The two anterior lower molars are quadrituberculate with a posterior step. The posterior lower molar has a notched anterior cusp and rounded posterior tubercle. The anterior lower molar has the anterior cusp but shallowly notched. With age, an anterior step is developed in the first and second lower molars which does not exist in unworn teeth.

APOMYS HYLOCÆTES, new species.

MOUNT APO FOREST-MOUSE.

Tah-dee'-ahn (Bagobo).

Type.—Adult female (skin and skull), Cat. No. 125246, U.S.N.M. Collected on Mount Apo at 6,000 feet altitude, southern Mindanao, Philippine Islands, July 2, 1904, by Edgar A. Mearns. (Original number, 5696.)

Characters.—Those of the genus, of which it is a medium-sized member. Head large and rounded; tail scantily and very finely haired above and below, the rings distinctly visible throughout, the hairs between the verticelli extending to the tip of the tail and measuring about 2 mm. in length; caudal annuli numbering about 16 to the centimeter; tip of tail white for about 20 mm.; soles of feet entirely naked. In this species the tubercles of the hind foot are more crowded and the two innermost much larger than in *Apomys insignis* (described on page 459), the posterior tubercle averaging 6 mm. in length.

Color.—The type has the upperparts mummy brown, and the underparts cinnamon-fawn, with a white area in the center of the chest; back, and especially the top of the head finely mixed with black; end of muzzle, and throat, drab-gray; outer surface of fore limbs mouse gray; fore feet whitish; hind feet pale drab-gray above, becoming whitish on the toes, which are tufted at the base of the claws; claws horn color; soles flesh color tinged with drab-gray; tail purplish slate above, pale drab-gray below, white all round at tip; whiskers mixed white and brownish black; naked ears smoke gray; wrists drab-gray below; ankles seal brown; pelage of upperparts blackish slate at base, of underparts (except in the white area) slate-gray. A young male

(Cat. No. 125243, U. S. N. M., from the same locality, June 26, 1904), just emerged from the gray juvenile pelage, has the upperparts sepia brown, much mixed with black, and the underparts smoke gray with a cinnamon-white area in the middle of the chest. The tail to the unaided eye appears naked, but is covered throughout with downy hairs. This, like the remaining specimens of this species, has the tip of the tail white.

Skull and teeth.—Braincase inflated; upper profile of skull straight and slightly declining anteriorly, very strongly arched posteriorly; audital bullæ rounded and very high; rostrum slender, elongate; nasals greatly expanded anteriorly, sharply compressed in the middle, thence tapering to a slender point ending, at base, opposite the fronto-maxillary suture.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125246, U.S.N.M., type.
Basilar length (Hensel)	mm. 22.3
Occipito-nasal length	31
Interparietal breadth	14
Interorbital breadth	5
Length of internasal suture	11.5
Length of upper molar series	5.9
Antero-posterior diameter of audital bulla	4

Measurements of five specimens from Mount Apo, Mindanao.

Measurement (taken fresh).	No. 125246, U.S.N.M., ^a type.	No. 125249, U.S.N.M., ^a 6,750 feet.	No. 125252, U.S.N.M., ^a 6,000 feet.	No. 125250, U.S.N.M., ^b 6,750 feet.	No. 125251, U.S.N.M., ^b 6,000 feet.
	mm.	mm.	mm.	mm.	mm.
Total length	250	248	265	263	268
Tail to end of vertebrae	135	131	145	142	150
Tail to end of hairs	137	132	147	(c)	151
Hind foot	31	30	31	31.5	32
Head	35	37	37	38.5	39
Ear above crown	15	14.4	15	16	15
Ear above notch	20	20	20	20	21

^a Adult female.

^b Adult male.

^c End of tail gone.

Specimens examined.—Eight, 2 skins with skulls and 6 (3 males and 3 females) in alcohol, all from Mount Apo, southern Mindanao. Four came from the altitude of 6,000 feet and 4 from 6,750 feet.

Remarks.—Paler-colored feet and ears distinguish this species from the largest *Apomys*. The soles of the feet are flesh colored instead of purplish slate. The feet are broader, with larger tubercles, especially as to the two postero-internal ones.

APOMYS PETRÆUS, new species.

MOUNT APO ROCK-MOUSE.

Type. Adult female (skin and skull), Cat. No. 125245, U.S.N.M. Collected on Mount Apo at 7,600 feet altitude, southern Mindanao, Philippine Islands, June 30, 1904, by Edgar A. Mearns. (Original number, 5690.)

Characters.—Those of the genus, of which it is the smallest known species. Form and pelage like *Peromyscus*. Tail moderately hairy above and below, dark-colored above to the naked tip; caudal annuli about thirteen to the centimeter; hairs of tail about two caudal rings in length on upper surface; soles of feet naked except at the heel.

Color.—The type has the upperparts a beautiful russet or mars brown color; underparts pale fawn color, the colors of the upper and under parts blending on the sides; muzzle, throat, and inner aspect of fore limbs smoke gray; outer surface of fore limbs mouse gray; wrists whitish below; feet smoke gray, fading to whitish on toes; claws horn color; tail pale, purplish brown above, flesh color below; whiskers mixed white and brownish black; naked ears drab-gray; iris dark brown; hair of upperparts slate-gray at base, of underparts drab-gray. A second specimen, an adult female topotype (Cat. No. 125244, U.S.N.M.), differs from the type in being considerably darker, principally from a fine admixture of black annuli and tips in the pelage of the upperparts. Prout's brown approaches the general effect nearer than any other shade in Ridgway's Nomenclature of Colors. The color of the underparts lacks the cinnamon tinge of the type, being nearer clay color than fawn or cinnamon, and has a tendency to whiteness in the hinder part of the belly.

Skull and teeth.—Braincase swollen in the parietal region; upper profile of skull straight and slightly declining anteriorly, strongly arched posteriorly; audital bullæ high and rounded; rostrum moderate; nasals expanded apically, tapering gradually to a pointed base opposite the fronto-maxillary suture.

Specimens examined.—Two adult females (skins with skulls), from a rocky talus at the altitude of 7,600 feet, above the forested portion of Mount Apo, taken June 28 and 30, 1904.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125245, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	22
Occipito-nasal length.....	29.5
Interparietal breadth.....	14
Interorbital breadth.....	5.1
Length of internasal suture.....	11.5
Antero-posterior diameter of audital bulla.....	4
Length of upper molar series.....	5.8

External measurements of two adult females from Mount Apo, Mindanao.

Measurement (from fresh specimens).	No. 125245, U.S.N.M., type.	No. 125244, U.S.N.M., topotype.
	mm.	mm.
Total length.....	231	236
Tail to end of naked tip.....	120	122
Length of hind foot.....	30	28
Length of head.....	37	35
Ear above crown.....	16	15
Ear above notch.....	20	19

APOMYS INSIGNIS, new species.

GREAT APO MOUSE.

Tah-ko'-bo Oom-bough'; *Omb-boi'-say Oom-bough'* (Bagobo).

Type.—Adult female (skin and skull), Cat. No. 125230, U.S.N.M. Collected on Mount Apo at 6,000 feet altitude, southern Mindanao, Philippine Islands, July 8, 1904, by Edgar A. Mearns. (Original number, 5711.)

Characters.—Those of the genus, of which it is the largest known species; caudal rings about 12 to the centimeter; tubercles of hind feet small and widely separated, the largest measuring less than 5 mm. in length; longest whiskers 60 to 65 mm. in length.

Color.—Upperparts mummy brown; underparts cinnamon-fawn, with a white area in the middle of the chest, top of head and back very finely mixed with black; end of muzzle and throat drab-gray; fore leg seal brown externally; fore feet white; hind feet whitish drab above; toes white, tufted at base of claws; naked soles and ear purplish slate; tail purplish slate, paler below, but not distinctly bicolor; three of the fourteen specimens with extreme end of tail white; whiskers mixed white and black; wrists clay color below; ankles seal brown; pelage of upperparts slate color at base, of underparts (except in the white area) slate-gray. Iris dark brown; claws horn color. The white area of the underparts varies from a small stripe between the fore-legs to a broad, irregular ventral band ending near the vent. In one case the white stripe is interrupted.

The young are mouse gray, becoming washed with brown above and cinnamon below as they grow older.

Skull and teeth.—Braincase flattened as compared with the other species of *Apomys*; anterior profile of skull flat and level; rostrum thickened; nasals evenly tapering to an acute base even with the fronto-maxillary suture; audital bullæ less inflated and rounded; teeth large.

Cranial measurements of the type, an adult female, from Mount Apo, Mindanao.

Measurement.	No. 125230, U.S.N.M., type.
	mm.
Basilar length (Hensel).....	24
Occipito-nasal length.....	32
Interparietal breadth.....	13.5
Interorbital breadth.....	5
Length of internasal suture.....	12
Antero-posterior diameter of audital bulla.....	4.6
Length of upper toothrow.....	6.1

External measurements of fourteen specimens of Apomys insignis.^a

U.S.N.M. Cat. No.	Original No.	Sex and age.	Length.	Tail verte- bræ.	Tail hairs.	Hind foot.	Head	Ear, crown.	Ear, notch.
			mm.	mm.	mm.	mm.	mm.	mm.	mm.
125230	5711	Female adult.....	287	176	178	35	37	16	20
125231	5726	Female juvenile..	217	123	.....	32.5	.....	.....	.....
125232	5659	Male adult.....	261	154	155	34	38	16.5	20
125233	5660	.....do.....	261	150	151	34	38	16.5	20
125235	5662	.....do.....	275	153	154	35	38	16	22
125236	5663	.....do.....	268	152	153	35	37	16	22
125240	5695	.....do.....	254	142	144	34	36	15	19
125242	5697	.....do.....	284	164	166	36	38	17	21
125234	5661	Male immature....	233	133	.....	34	.....	.....	.....
125237	5664	.....do.....	266	164	.....	34	.....	.....	.....
125238	5665	.....do.....	239	140	.....	34	.....	.....	.....
125239	5666	.....do.....	217	128	.....	31	.....	.....	.....
125241	5683	.....do.....	255	155	157	34	35	17	20
125247	5721	.....do.....	250	144	146	35	35	15	20

^aTaken from fresh specimens.

Specimens examined.—Fourteen, of which two are in alcohol, the remainder skins with skulls. All are from Mount Apo, Mindanao, Philippine Islands, taken June 20 to July 12, 1904, at altitudes of 4,000 (2) and 6,000 (12) feet. Two are females, the remainder males.

Remark.—The type, taken on July 8, contained two small fetuses.

ON A COLLECTION OF ORTHOPTERA FROM SOUTHERN ARIZONA, WITH DESCRIPTIONS OF NEW SPECIES.

By ANDREW NELSON CAUDELL,
Of the Department of Agriculture.

The majority of the Orthoptera here noted were taken by E. J. Oslar, mostly in the Huachuca Mountains, during the summer of 1903. A few other species have been added, but where not otherwise mentioned the specimens were collected by Oslar. All the specimens are now deposited in the United States National Museum.

SPONGOPHORA APICIDENTATA, new species.

One male, one female. Tucson, Arizona, January 14, on giant cactus, by H. G. Hubbard.

Description.—In size and general appearance very like *S. brunneipennis*, the female being practically indistinguishable from that species. The males, however, differ quite decidedly from *brunneipennis* in the form of the forceps, which are shorter, more incurved, and armed with a single tooth, near the apex, and by having the pygidium wider and more broadly concave apically. Lateral folds of the abdomen, as in *brunneipennis*. The antennae seem to consist of but fourteen segments, but some of them may be missing.

Length, male, 9 mm.; female, 8 mm.; forceps, male, 3 mm.; female, 3 mm.

Type.—Cat. No. 8257, U.S.N.M.

Besides the types, I have seen six males and one female from the same place, taken under the same circumstances, one male and two females from Los Angeles and San Diego counties, California, as well as several females, probably belonging here, from Catalina Springs and Fort Yuma, in Arizona, and a few taken under old leaves near Columbia, Texas.

The apparently fourteen segmented antennae would serve to locate

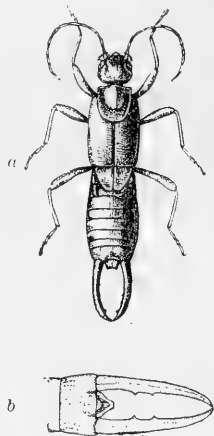


FIG. 1.—a, SPONGOPHORA APICIDENTATA. b, TERMINAL SEGMENT OF ABDOMEN OF *S. BRUNNEIPENNIS*.

this species in the genus *Labia*, but its close relationship to *Spongophora brunneipennis* seems to justify its being placed as congeneric with that species. While normally with fifteen segments in the antennæ, many specimens of *S. brunneipennis*, even with antennæ seemingly perfect, have but fourteen. But in most forficulids the structure of the antennæ is such as to make it very difficult to tell if all the segments are present or not. The number of antennal segments in our species of *Spongophora*, and probably of some other genera, may be found to vary somewhat.

Apicidenata, as a whole, differs from its ally in being a little smaller, the female seemingly less elongate as a rule, and generally with the wings more unicolorous. A figure of the apex of the abdomen of a male *brunneipennis*, showing the pygidium and forceps, is given for comparison.

ISCHNOPTERA UHLERIANA Saussure.

One male, Patagonia Mountains, May 15; one male, Huachuca Mountains, August 22.

BLATTA ORIENTALIS Linnæus.

One male, Nogales, June 20.

The males of this species exhibit considerable variation in the length of the elytra, some having them but twice as long as the pronotum while in others they are two and one-half times as long.

PERIPLANETA AMERICANA Linnæus.

One immature female, Nogales, June 14. Also an adult male from Florence, Arizona, collected by Beiderman, and an adult female from Yuma, Arizona, taken by H. Brown.

This nymph from Nogales is colored more like *P. australasiæ*, and would have been considered as that species but for the lack of records of this species from Arizona.

HOMŒOGAMIA APACHA Saussure.

Five males, Nogales, June 17, July 25; three males, Huachuca Mountains, August 20 to 28.

The U. S. National Museum contains specimens of *apacha* from California and Arizona, and of *H. erratica* from Arizona, Texas, Colorado and New Mexico. Color and interocular space are not always correlated in these two species. Thus their distinctness is not so striking as was once thought.

A male taken at Phoenix, Arizona, on June 9, 1904, by R. E. Kunzé is wholly infuscated, except for a pale emargination of the front and sides of the pronotum and the anterior third of the costal

margin of the elytra. It corresponds with the variety *nigricans* of *H. bolliana*, and may be called *H. apacha* var *infusata*.

A typical male *apacha*, also taken by Kunzé at Phoenix, on May 13, is below the record in size, measuring as follows: Length of elytra, 12 mm.; pronotum, 3.5 mm.; width of pronotum, 4.5 mm.

YERSINIA SOLITARIA Scudder.

One specimen, apparently immature, Huachuca Mountains, August 13.

This species occurs also in New Mexico, one of the specimens recorded as *Litaneutria minor* by Scudder and Cockerell^a being this species. I also have it from Las Vegas Hot Springs, New Mexico, August 11, and Dimmit Lake, New Mexico, August 21, all collected by Cockerell.

LITANEUTRIA MINOR Scudder.

There are specimens of both sexes in the collection of the U. S. National Museum. From a study of Scudder's original specimens it is seen that the four species now contained in our lists are very nearly allied to each other. *Obscura* and *pacifica* are scarcely distinct from *minor*, and *borealis* is retained with much doubt, being known only from the female, and separable from typical *minor* only by the smoother pronotum, a variable character. These nominal species are separable as follows:

1. Wings of the males without a subbasal fuscous spot.....*pacifica*.
Wings of the males with a subbasal fuscous spot.....2.
2. Wings of the males quite deeply fuliginous throughout.....*obscura*.
Wings of the males, aside from the subbasal fuscous spot, lightly fuliginous....3.
3. Pronotum roughened in the female.....*minor*.
Pronotum smoother in the female.....*borealis*.

Typical *minor*, represented in the U. S. National Museum by six males and six females from Colorado, Arizona, and California, has the wings of the males lightly fuliginous, rarely if ever completely hyaline. This infuscation is variable and merges into the *obscura* type.

Obscura, represented in the national collection by four males and four females from Arizona and California, has the wings of the males wholly infuscated more deeply than in typical *minor*. The elytra is also usually much darker and the veins more distinctly marked with black than in *minor*. One specimen from California, however, has the elytra light colored as in *minor*, and this specimen has the anal are of the elytra infuscated at the base.

Pacifica, not represented in the collection of the U. S. National Museum, has the wings of the males feebly and uniformly fuliginous, the subbasal fuliginous spot not represented.

^a Proc. Davenp. Acad. Sc., IX, 1902, p. 10.

Borealis, represented by two females from Colorado, is scarcely distinguishable from *minor*, the pronotum of the female being somewhat less tuberculous than in typical *minor*. The female elytra also seem slightly more elongate in the specimens before me.

The length of the elytra of these insects varies considerably in the males, the maximum being 22 mm. and the minimum 16 mm. The few specimens before me, however, exhibit a complete gradation from the greatest to the smallest measurement. The females have the wings infuscated mesially for nearly their entire width. As a rule the females, being inseparable, must be placed according to their locality unless associated with the males. A sufficient amount of fresh material would very probably justify the reduction of one or more of these species to the rank of variety.

STAGMOMANTIS LIMBATA Hahn.

Nine males, Nogales, June 15, August 3; one male, one female, Huachuca Mountains, June 29, August 13. Two immature females, Catalina Mountains, June 6.

This species is readily distinguished from *carolina* by the female having the costal area of the elytra much broader and by that of the male being opaque instead of transparent or translucent, as in *carolina*.

BACTROMANTIS VIRGA Scudder.

Four males, Huachuca Mountains, August 15. Four males, Nogales, June 15, July 19.

These specimens are larger than a single male specimen in the U. S. National Museum from Phoenix, Arizona. The elytra of this latter measures but 21 mm. and the pronotum 9 mm., while the elytra of the former measure 24 to 26 mm. and the pronotum 11 mm., except one of the specimens from Huachuca Mountains, which is scarcely larger than the one from Phoenix.



FIG. 2.—*VATES TOWNSENDI*, SIDE VIEW.

VATES TOWNSENDI Rehn.

Vates townsendi REHN, Proc. U. S. Nat. Mus., XXVII, 1904, p. 573.

Two males, Nogales, June 14, July 18.

The first reference of the occurrence of this handsome insect within the United States was by the writer in February, 1903,^a under the

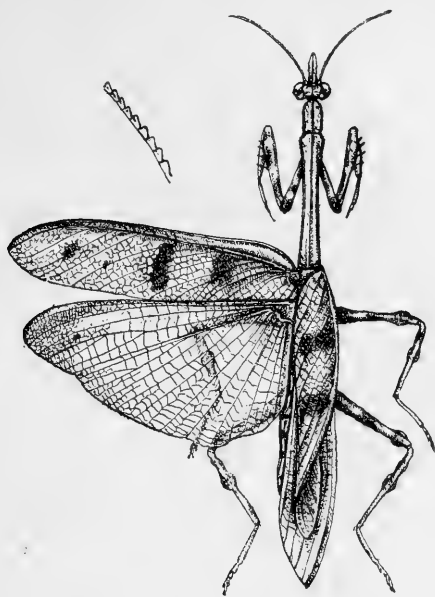


FIG. 3.—*VATES TOWNSENDI*, TOP VIEW.

name *Vates* sp., the record being based upon an immature specimen. A figure of the adult male, made from these Arizona specimens, has already been published and is here reprinted.^b

PARABACILLUS COLORADUS Scudder.

One male, Huachuca Mountains, August 18.

SYRBULA FUSCOVITTATA Thomas.

Two males, Huachuca Mountains, August 17. Altitude, 8,000 feet.

HESPEROTETTIX CURTIPENNIS Scudder.

One male, Hot Springs, July 2. Two females, Flagstaff, Arizona, June 7 (Barber and Schwarz, collectors).

This species was described from females taken in Colorado, and until now the male has remained unknown.

Description of male.—General color greenish. Head moderately prominent, green with a darker green line above and paler next the eyes above; vertex moderately tumid, slightly elevated above the pronotum; interocular space less than the width of the basal segment of

^aProc. Ent. Soc. Wash., V, 1903, p. 165.

^bJourn. N. Y. Ent. Soc., XIII, 1905, pl. III.

the antennæ: fastigium rectangular, very declivate, moderately sulcate with the bounding carinæ rounded; frontal costa just failing to reach the clypeus, moderately sulcate, more deeply between the antennæ, about as broad as the interocular space with sides parallel to near the vertex, where they converge to meet the fastigium. Eyes moderately large and prominent, considerably longer than the infraocular portion of the genæ. Antennæ rufotestaceous, obscure basally, about twice as long as the pronotum, apically blunt. Thorax rounded, sides parallel, scarcely expanded posteriorly, color greenish with a slender light dorsal line, and the lateral lobes marked with an elongate black spot terminating at the posterior sulcus and not quite reaching the anterior margin of the pronotum and bordered below with an ashy stripe; prozona nearly smooth; metazona somewhat rugulose, slightly punctate; anterior margin of the pronotum roundly truncate, hind margin obtuse angulate, the angle a little rounded; lateral carinæ not represented, median carina subobsolete, scarcely noticeable except on the metazona and there inconspicuous; transverse sulci slender but well developed, not lined with black; prozona nearly twice as long as the metazona. Prosternal spine short, pyramidal, well pointed and erect; interspace between the mesosternal lobes subquadrate, a little longer than broad; interspace between the metasternal lobes elongate, much longer than broad. Elytra abbreviate, scarcely as long as the pronotum and just touching each other above, scarcely overlapping, apically roundly pointed, the costal margin well rounded; color uniformly green; wings aborted. Fore and middle femora considerably and equally swollen, light brown in color; tibiæ and tarsi dark green, spines black; posterior femora moderately stout, uniformly green on the outer face, lighter below and on the inner face, rufescent above, unbanded; posterior tibiæ and tarsi greenish blue, the spines tipped with black, ten to eleven in outer series. Abdomen brownish above and below, very faintly tinged with greenish, apically scarcely swollen and very little upturned; supraanal plate triangular, centrally elevated and briefly and broadly sulcate, the tip beyond the median elevation with a slight but deep sulcus; furcula mere projections, no longer than broad, lying within the bounding walls of the median sulcus of the supraanal plate; cerci just reaching the tip of the supraanal plate, simple, tapering throughout, more rapidly in the basal half, the tip sharp and moderately incurved; subgenital plate no longer than broad, the subapical tubercle prominent.

Length 17 mm., antennæ 9 mm., pronotum 4.5 mm., elytra 3.5 mm., posterior femora 9.5 mm.

PSOLOESSA BUDDIANA Bruner.

One male, three females, July 17 to 30.

A female type of this species is in the U. S. National Museum and, like this series, it has the foveolæ visible from above for their entire length, thus differing from the other United States members of the genus, and in this respect allied to the genus *Stirapleura*, where indeed it may belong. The pronotal structure, however, is that of *Psoloessa*. Except for the wholly visible foveolæ, some of the specimens are very close to *P. ferruginea*, but most are much darker than that species.

STIRAPLEURA PUSILLA Scudder.

One male, Huachuca Mountains, August 15. One female, Nogales, July 1.

ARPHIA ABERRANS Bruner, new species.

One male, one female, Nogales, June 24 to 29. One male, two females, Huachuca Mountains, August 12 to 27.

Professor Bruner has very kindly sent me the following description of this species, which he has previously recognized from a single female taken in the Huachuca Mountains by Mr. Kunzé.

His description is as follows:

ARPHIA ABERRANS, new species.

A rather slender, long-winged, grayish brown, profusely mottled insect with greenish-yellow wings and rather conspicuously banded hind femora.

Head of moderate size, about as wide as the front edge of the pronotum; the vertex gently depressed, its scutellum shallowly sulcate, oval (male) or pyriform (female), the bounding walls fairly prominent but not high; lateral foveolæ triangular, inconspicuous, rather flat and more or less filled with rugosities or coarse granules, frontal costa plane, scarcely sulcate, narrowing above to little less than its width at the ocellus and gradually merging into the sulcation of the vertex. Antennæ filiform, of moderate length. Pronotum a little constricted in advance of the principal sulcus, the disc moderately coarsely granulate; median carina fairly prominent, straight, cut in advance of the middle; anterior margin a little angulate, the hind margin right-angled. Tegmina of medium width, extending considerably beyond the tip of the abdomen in both sexes, the intercalary vein not especially prominent. Hind femora neither very heavy nor especially slender; about normal for insects of the group.

General color above, light grayish brown, profusely and rather evenly mottled and streaked with dark brown and dull black; below pale testaceous, the dorsum of the abdomen bluish tinged. Dorsum of prothorax obscurely decussate with paler, the sides and head back of eyes longitudinally streaked alternately with darker and paler dashes of brown and gray. Tegmina with the dorsal edge paler and nearly destitute of the otherwise rather general dusky markings. Wings transparent greenish-yellow on disc and along the anterior field nearly to the apex, the latter portion vitreous; fuliginous band rather broad but pale and broken by the radial veins, not quite reaching the anterior edge; tenia quite prominent and reaching nearly to the base. Hind femora thrice obliquely banded with fuscous internally

black banded with testaceous, below blue tinted; tibiae bluish with a rather broad, pale basal annulus, the tarsi testaceous.

Length of body, male 21, female 29 mm.; of antennae, male 7, female 7.5 mm.; of pronotum, male 4.85, female 5.5 mm.; of tegmina, male 23, female 25 mm.; of hind femora, male 12, female 15 mm.

Habitat.—North America, Huachuca Mountains, Arizona, 1 female (R. E. Kunzé); Nogales, Arizona, 1 male, 1 female; Huachuca Mountains, 1 male, 2 females, Oslar (Coll. U. S. Nat. Mus.).

Type.—Cat. No. 8258, U.S.N.M.

This insect reminds me very much of some of the pale winged species of *Trimeroptis*, to which it bears a strong resemblance at first glance. The species seems to be rather local in its distribution, but may occur across the boundary line in Mexico as well.

HIPPISCUS CORALLIPES Haldeman.

One female, Catalina Mountains, June 6.

Scudder, in his table,^a says the inside of the hind femora is blue, but the original description gives it as bright vermilion. This specimen from Catalina Mountains agrees with the original description. *Hippiscus conspicuus* is nearly allied to this species.

LEPRUS CYANEUS Cockerell.

One female, Nogales, August 1.

LACTISTA OSLARI, new species.

One male, Nogales, July 3.

Description.—Ashy gray, heavily mottled with brown. Head scarcely prominent, no wider than the posterior portion of the pronotum, brown above, the lower half paler; vertex little elevated and with two oval areas bounded by well-elevated carinae, less distinctly so in front where they join the elongate, somewhat declivate fastigium, which is deeply sulcate and with the bounding walls well elevated, fastigium without median carina; interocular space not quite as broad as the width of one of the eyes, nearly twice as wide as the basal segment of the antennae; frontal costa percurrent, somewhat narrower than the interocular space, sulcate at and below the ocellus, flat and lightly punctate above the ocellus and angularly expanded at the intersection with the fastigium. Eyes moderate, quite prominent, about as long as the infraocular portion of the genae. Antennae brown, about as long as the head and pronotum. Thorax compressed, slightly widening behind; color brownish, with very obscure darker flecking on the sides; surface smooth, except on the disk where it is slightly rugose, anterior margin scarcely angulate, posterior margin acute-angulate, the apex quite sharp; lateral lobes slightly deeper than long, the posterior-inferior angle broadly rounded; lateral carinae rounded, subobsolete and broken before the

^a Psyche, VI, 1892, p. 278.

principal sulcus, more distinct and sharp on the metazona; median carina percurrent, considerably and evenly elevated, suberistate, cut by one sulcus only; transverse sulci cutting the lateral carinae and well developed on the lateral lobes. Interspace between the mesosternal lobes half as broad again as long, of metasternal lobes quadrate. Tegmina moderately slender, intercalary vein well developed and apically nearer the median than the ulnar vein, color brownish with a large, light-gray rectangular spot on the costal area just beyond the humeral angle and a trace of the same color before the angle and also beyond the costal spot; the lower portion of the tip is transparent membranous, and the whole elytra is marked with darker blotches. Wings broad, about two-thirds as broad as long; basal half, or a little more, yellow, followed by a moderately broad fuscous band which fails to reach the anal angle below, interrupted narrowly at the first anal vein and sending a tænia about half way to the base; beyond the fuscous band the wing is transparent with fuscous veins and with the apex again becoming infuscated; stigma fuscous. Legs moderately slender, fore and middle pairs brownish mottled lightly with fuscous; posterior femora with two black bars across the dorsal surface, scarcely extending across the brownish outer face, which has a pregenicular ashy band; inner face black with a broad pregenicular light band; geniculations black on the inner side, fuscous on the outer; hind tibiae blue with a light-colored basal band; spines black to the base, nine to ten in outer series. Abdomen light brown, darker above, moderately slender.

Length 18 mm., antennæ 7.5 mm., pronotum 4.25 mm., elytra 19 mm., posterior femora 10 mm., greatest width of elytra 4 mm., wing 11 mm.

Type.—Cat. No. 8261, U.S.N.M.

I have also a female taken by Osler at Albuquerque, New Mexico, without date. It is like the male, except the pronotum is somewhat more rugose and the tips of the wings are less infuscated. It measures as follows: Length 22 mm., antennæ 7.5 mm., pronotum 5 mm., elytra 23 mm., greatest width of elytra 4 mm., of wings 11.5 mm.

Professor Bruner says this is near to, but distinct from, *L. gibbosus*. He also compared it with *pellepidus* and *punctatus* and found it different. The *L. boscanus* of Rehn has also been seen.

The insect recorded from New Mexico by Scudder and Cockerell^a as *Lactista pellepidus* is *Tomonotus aztecus*, as determined by careful comparison of those specimens in the Scudder collection with typical *aztecus* from Texas identified by Bruner.

^aProc. Davenport Acad. Sc., IX, 1902, p. 31, pl. III, fig. 1.

TOMONOTUS AZTECUS Saussure.

Two males, three females, Nogales, July 19 to 30. One male, one female, Huachuca Mountains, August 12 to 15.

Besides these specimens, the U. S. National Museum contains specimens from Organ Mountains, New Mexico, taken by Townsend at an elevation of 5,700 feet in Filimore Canyon and a few specimens from the same region by Cockerell in September.

TOMONOTUS FERRUGINOSUS Bruner, new species.

Two males, two females, Huachuca Mountains, August 11 to 18. One female, Nogales, no date.

Professor Bruner has furnished the description and following table of species of *Tomonotus* of *T. ferruginosus* in advance of their publication in his work in the Biologia Centrali-America, Orthoptera. II.

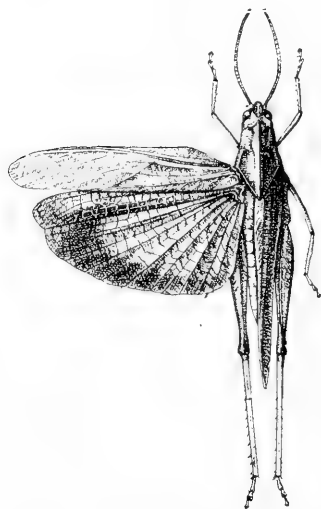


FIG. 4.—*TOMONOTUS FERRUGINOSUS*,
TOP VIEW.

Description.—In general structure nearest to *T. mexicanus* Saussure, but differing from that insect in its somewhat slenderer form, less strongly granulous head and thorax, in the more elongate and angulate pronotum, the longer and narrower antennae, the plain unbanded hind tibiae and hind femora, and in being of a uniform ferruginous color throughout instead of having the tegmina and body mottled and marbled with fuscous. The present species also differs from the insect with which it has been compared in having the wings tile red instead of rose color and the margin along with the shorter and less conspicuous tenia smoky brown instead of fuliginous. Its hind tibiae vary from pale greenish yellow, female, to glaucous, male, while in *mexicanus* these members are pale and dark banded as in *Spharagemon bolli*.

Length of body, male 20 mm., female 32 mm.; pronotum, male 6.5 mm., female 8.5 mm.; antennae, male 8 mm., female 10.5 mm.; tegmina, male 20.5 mm., female 28 mm.; hind femora, male 13 mm., female 17 mm.

Habitat.—Fort Grant, Arizona (Collector L. Bruner); Santa Rita Mountains, Arizona (E. A. Schwarz); Phoenix, Arizona (R. E. Kunzé); Huachuca Mountains, Arizona (E. J. Osler); California (A. Koebele).

TABLE OF SPECIES OF THE GENUS TOMONOTUS.

- A. Tegmina with their apices obliquely truncate. Head and pronotum rather roughly granulose; the scutellum of the vertex gently declivent; wrinkled. Eyes smaller. Pronotum cristate or subcristate, decidedly angulate in front. Wings some shade of red, the band following the border to anal angle. Spurs of the hind tibiae rather unequal in length, the outer ones being much shorter than the inner. Antennae decidedly flattened.
- B. Pronotum strongly compressed, elevato-lamelliformly cristate, this strongly and obliquely fissured; the anterior and posterior edges both angulate, upper carina of hind femora suddenly narrowed beyond the middle.

- C. Color variable, varying from cinereous to fulvo-fuscous mottled and mar-
 morate, with blacker dark brown. Wings rose color, with a narrow fuscous
 border and a prominent tænia reaching to the base; apex emarginately
 vitreous. Hind edge of disk of pronotum little acute. Hind tibiæ banded
 with fuscous and testaceous.....*mexicanus* Saussure.
- C C. Color uniformly ferruginous, without darker mottling, and marbling.
 Wings tile color, the fuscous border faint, the tænia inconspicuous and
 not reaching the base of the wing, the apex not perceptibly hyaline.
 Hind edge of disk of pronotum decidedly acute. Hind tibiæ unicolor-
 ous, pale testaceous to glaucous.....*ferruginosus*, new species.
- B B. Pronotum above plane, more gently cristate, the severing not oblique; ante-
 rior edge very obtusely angulate, behind subacute. Wings bright car-
 mine, the tænia and border deep black; apex emarginately vitreous.
 Upper carina of hind femora not suddenly narrowed.....*arizabæ* Saussure.
- A A. Tegmina with their apices rounded. Head and pronotum less strongly gran-
 ulate; scutellum of the vertex more strongly declivent, smoother. Eyes
 larger. Pronotum carinate, but in nowise cristate; the anterior border sub-
 truncate. Wings yellow, the fuscous band not reaching the anal angle.
 Spurs of hind tibiæ not greatly unequal.....*aztecus* Saussure.

The above-described new species is very like a red winged *Arphia*,
 so much so indeed that it is very liable to be taken as such. The
 sternal characters serve, however, to separate it from the members of
 that genus.

MESTOBREGMA GRACILIPES, new species.

Two males, Nogales, June 30, July 21. Two females. Huachuca
 Mountains, August 25 and 27.

Description.—Light gray, conspicuously marked with fuscous.
 Head prominent, strongly elevated above the pronotum; color fuscous
 above with longitudinal light stripes, in front and below ashy with the
 face ornamented with a V-shaped black mark beginning below each
 eye and meeting on the clypeus; the sides are also marked with a
 horizontal black line parallel with the side of the V-shaped mark but
 much less conspicuous; vertex flat, inclined upward and at vertex
 between the eyes with an interrupted transverse carina; interocular
 space about as broad as one of the eyes in the female and scarcely as
 broad in the male, about twice as broad as the basal segment of the
 antenna; fastigium of the vertex declivate, moderately sulcate with
 well-elevated walls, narrowing anteriorly to meet the walls of the
 frontal costa from which it is not separated by transverse carinae;
 media carina absent; frontal costa not reaching the clypeus, at
 narrowest point, above the ocellus, about one-third as broad as the
 interocular space, male, or about one-fourth as broad, female, deeply
 sulcate, the walls well elevated and diverging uniformly. Eyes very
 prominent, hemispherical, about as long, male, or not as long, female,
 as the infraocular portion of the genæ. Antennæ rufotestaceous,
 slender, slightly, female, or considerably, male, longer than the head

and pronotum. Thorax mesially somewhat compressed, disk clepsydral in shape and markings, the marking light on dark background; lateral lobes higher than broad, the lower margin descending, causing posterioventral angles to be acute, though not very sharply so; color fuscous on disk, margined above and behind with ashy and a more or less distinct square spot of the same color on the anterioventral angle and a slight semicircular spot on the center of the disk; anterior margin of the disk truncate, posterior rectangular, the sides straight; median carina distinct, equally elevated throughout, cut a little in front of the middle by the principal sulcus and in front of that point cut very inconspicuously by the anterior sulcus; lateral carinae slight and the lateral lobes furnished about the middle of the upper half with a short longitudinal carina, not reaching the anterior margin of the pronotum and terminating at the anterior sulcus; interspaces between the mesosternal and metasternal lobes about twice, male, or more than

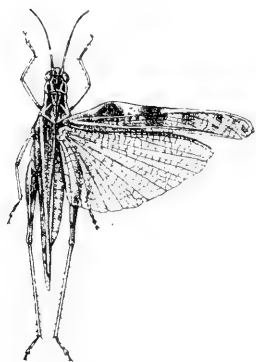


FIG. 5.—*MESTOBREGMA GRACILIPES*, TOP VIEW.

twice, female, as broad as long. Elytra long and slender, nearly seven times as long as broad; color light with a large triangular fuscous spot at the humeral angle, a quadrate spot about the same size located its own width from the triangular spot on the costal margin and three or four less conspicuous rounded spots beyond on the costal area; the tip of the elytra is membraneous with the veins infuscated, the anal area pallid, basally infuscated in male and wholly obscured in the female; intercalary vein well developed. Wing long and pointed, about twice as long as broad, transparent with the basal fifth washed with citrus, a bluish costal stigma

beyond the middle, no trace of a transverse fuscous band. Legs weak and very slender, the anterior and intermediate femora scarcely more than one-half as broad as the interocular space, color light gray with darker mottlings; posterior femora slender, pallid with the inner face infuscated basally and the outer face with a short median black streak and the dorsal surface marked with three oblique black spots, conspicuous but small; hind tibiae light yellowish, the spines black tipped, seven to ten or eleven in outer series. Abdomen slender, pale yellowish, more or less infuscated above and, in female, on the sides.

Length of body, male 17 mm., female 23 mm.; antennae, male 9 mm., female 9 mm.; pronotum, male 3.5 mm., female 4 mm.; elytra, male 17 mm., female 23 mm.; posterior femora, male 10.5 mm., female 13 mm.; greatest width, elytra, male 2.5 mm., female 3.5 mm.; wing, male 7.5 mm., female 10 mm.

Type.—Cat. No. 8259, U.S.N.M.

This species is allied, in shape of wings, to the *M. rosaceus* of Scudder, of which my *Aræopteryx pendlopæ* is a synonym as determined by direct comparison with Scudder's type. *Pendlopæ* has been referred to by Rehn as synonymous with *Trepidulous rosaceus* McNeill. This species, as well as the one here described and certain others, are apparently generically distinct from typical *Mestobregma*, and either *Trepidulous* or *Aræopteryx* should properly be applied to them, depending upon whether or not *Trepidulous* is the same as *Aræopteryx*. The type of *Trepidulous* should be in the U. S. National Museum, but, like a lot of other type material, was retained by the describer, all efforts toward having it returned so far failing.

MESTOBREGMA PLATTEI Thomas.

One male, two females, Nogales, July 30.

CONOZOA SULCIFRONS Scudder.

Five males, one female, Nogales, July 15 to 31. Two males, Huachuca Mountains, August 20.

TRIMEROTROPIS ALLICIENS Scudder.

Trimerotropis alliciens SCUDDER, Proc. Davenport Acad. Sc., IX, p. 37, pl. II, fig. 1, 1902.

Two males, Nogales, July 31.

These specimens were compared with Scudder's types. Except for the elytral bands being a very little more distinct in the type specimens there seems to be no difference between them.

TRIMEROTROPIS BRUNERI McNeill.

Two males, July 21, August 2. One male, one female, Huachuca Mountains, August 11 to 13.

Trimerotropis fascicula is quite certainly not distinct from this species and *T. modesta* is probably but a stronger marked form of the same.

TRIMEROTROPIS CYANEIPES Bruner.

Four males, seven females, Huachuca Mountains, August 12 to 20.

These were taken at an altitude of 8,000 feet. One of the males has the blue disk of the wing deeply tinged with sea green.

TRIMEROTROPIS LATICINCTA Saussure.

One male, five females, Huachuca Mountains, August 12 to 29. Two females, Nogales, July 11 to 21.

Taken at an altitude of 8,000 feet. Some specimens of this species rival *melanopleura* in the width of the wing band.

TRIMEROTROPIS VINCULATA Scudder.

Four males, five females, Huachuca Mountains, August 11 to 25. Twenty-three males, sixteen females, Nogales, June 17 to August 2. Six males, one female, Patagonia Mountains, May 15. One male, two females, Catalina Mountains, June 6.

This series is very uniform in coloration, but shows considerable variation in shape of the thorax, some having the pronotum much longer and more slender than others, the short broad form approaching McNeill's *saratitis*.

HADROTETTIX TRIFASCIATUS Say.

Six males, two females, Huachuca Mountains, August 12 to 29.

Some of these specimens are labeled as having been taken at an elevation of 8,000 feet.

HELIASTUS ARIDUS Bruner.

One female, Huachuca Mountains, August 12.

The collection also contains a female from Albuquerque, New Mexico.

HELIASTUS BENJAMINI, new species.

One male, one female, Huachuca Mountains, August 16. One female, Nogales, July 5.

Description.—General color reddish brown, elytra banded with black, and the wings red in basal half. Head moderately prominent, color reddish brown above, lighter on the genæ and face; vertex scarcely tumid, somewhat elevated above the pronotum, especially in the male; interocular space considerably less than (male) or almost as (female) wide as the width of one of the eyes; fastigium moderately declivent, the bounding walls slight but distinct, no median carina; lateral foveolæ faintly impressed elongate triangular spaces, below each of which is a very distinct ocellus; frontal costa not nearly reaching the clypeus, about two-thirds as broad as the interocular space, expanded at the ocellus, also somewhat expanded at the lower extremity and above where it joins the vertex, the boundary walls but little elevated but sharp and distinct; eyes prominent, more so in the male, as long as (male) or considerably shorter (female) than the infraocular portion of the genæ; antennæ fuscous, basally more or less rufotestaceous, about (female) or more than (male) as long as the head and pronotum. Thorax rounded, broadening slightly posteriorly, quite uniformly reddish brown, the lateral lobes sometimes, not always, with a whitish central spot; surface smooth, slightly punctate on the metazona; lateral lobes as deep as long, the posterior-inferior angle rounded; lateral carinæ obsolete or, on metazona, bluntly indicated; median carina indicated only on the metazona, and there linear; transverse sulci well developed on lateral lobes, the posterior one dividing

the pronotum into nearly equal parts, the posterior probably a little the longer, at least in some females; interspace between the mesosternal lobes nearly twice (male) or more than twice (female) as long as broad, between the metasternal lobes slightly broader (male) or twice as broad (female) as long. Tegmina moderately slender, extending nearly a fourth of their length beyond the tips of the posterior femora; basally densely reticulate, apically more coarsely reticulate and membranous; color reddish brown, marked at the location of the humeral angle with a solid brownish-black band reaching completely across the elytra; beyond this transverse band are a number of more or less distinct blotches of a brownish color. Wings with the basal half red, except an obscure taniai interruption; beyond the colored disk the wing is transparent with infuscated veins, transverse fuscous band barely indicated; stigma fuscous, about one-fourth as long as the wing. Posterior femora stout and heavy, outer face brownish, with a moderately broad blackish bar across near the base of the outer half, faint in the female; inner face of the hind femora light in color with two broad, black transverse bars, the basal one sometimes extending to the base; hind tibiae yellowish basally, the inside blackish, ringed just before the middle more or less distinctly with black and beyond red; spines black tipped, eight (male), six to seven (female) in outer series; tarsi yellowish brown, tinged with red, usually decidedly reddish. Abdomen reddish brown, parallel not apically swollen in the male; valves of the female ovipositor unarmed, considerably scooped out; male subgenital plate apically acutely elevated a little above the supraanal plate; supraanal plate subtriangular, sides somewhat rounded, centrally tumid at the base, and with a short basal sulcus, scarcely more than one-fourth as long as the plate itself. Cerci simple, rapidly tapering in the basal half, the apical half scarcely half as broad as the basal portion.

Length, body, male 19 mm., female 25 to 30 mm.; antennae, male 12 mm., female 12 mm.; pronotum, male 4 mm., female 5.5 to 6 mm.; elytra, male 19 mm., female 23 to 24.5 mm.; posterior femora, male 11 mm., female 13 to 14 mm.; width at widest part, elytra, male 3.5 mm., female 5 mm.; wing, male 9.5 mm., female 11.5 mm.

Type.—Cat. No. 8260, U.S.N.M.

This species resembles somewhat the variety of *H. sumichrasti* described from Texas, but is more robust, has stouter posterior femora and has the elytra more distinctly banded. Mr. Rehn says the body is still smoother in *H. astecus*, with which he kindly compared these



FIG. 6.—*HELLASTUS BENJAMINI*.

specimens. He further states that the elytral band is less distinct and the legs more slender in *aztecus* than in the species here described.

I take pleasure in naming this handsome insect in honor of Dr. Marcus Benjamin, the editor of the Proceedings of the United States National Museum.

SCHISTOCERCA CARINATA Scudder.

Recently Doctor Kunzé submitted to me for identification a pair of this species taken by him at Phoenix, Arizona, October 11 and 18. They are now in the National Museum.

SCHISTOCERCA SHOSHONE Thomas.

One female, Huachuca Mountains, August 29; altitude, 8,000 feet.

SCHISTOCERCA VEGA Scudder.

Three males, Huachuca Mountains, August 22 to 27; six males, four females, Nogales, June 29 to July 19; four females, Oracle, June 9 to 12; two females, Catalina Mountains, June 6; one female, Patagonia Mountains, May 15.

While the females of this species seem quite uniform in size the males are quite variable in this respect. The extreme measurements exhibited by the males in this series, which perfectly intergrade, are as follows: Pronotum, 6 mm. to 8.5 mm.; elytra, 33 mm. to 44 mm.; posterior femora, 16.5 mm. to 22 mm.

Aside from the maculate lateral lobes of the prothorax and the more heavily maculate elytra, *vega* is very similar in appearance to *S. carinata*.

SCHISTOCERCA VENUSTA Scudder.

One female, Huachuca Mountains, August 15.

This species is very similar to *S. shoshone*, and should probably be considered as but a variety of it. The separating character, the median stripe of the pronotum, varies from conspicuous, typical *venusta*, to absent, typical *shoshone*.

CONALCAEA NEOMEXICANA Scudder.

One male, Huachuca Mountains, August 17.

The antennae are nearly as long as the posterior femora and are infuscated at the base and tip, the median portion reddish. The interspace between the mesosternal lobes is nearly twice as long as broad. The measurements of this specimen are as follows: Antennae, 12 mm.; thorax, 5 mm.; elytra, 4 mm.; posterior femora, 13.5 mm.

HORMILIA ELEGANS Scudder.

One female, Huachuca Mountains, August 15. One female, Catalina Mountains, June 6.

The specimen from Huachuca Mountains was taken at an altitude of 8,000 feet.

SCUDDERIA MEXICANA Scudder.

Three males, two females, Nogales, June 1 to July 30. One female, Huachuca Mountains, August 18.

MICROCENTRUM RETINERVE Burmeister.

Ten males, Nogales, June 17 to July 22.

CACOPTERUS PUNCTATA Scudder.

One immature male, Nogales, July 13.

CEUTHOPHILUS CALIFORNIANUS Scudder.

One male, Huachuca Mountains, August 18.

GRYLLUS PENNSYLVANICUS Burmeister.

One male, Patanonia Mountains, May 15. One female, Nogales, July 13.

GRYLLUS PENNSYLVANICUS var. **NEGLECTUS** Scudder.

One male, two females, Huachuca Mountains, August 16 to 23.

This is very surely the insect described many years ago by Mr. Scudder under the name *Gryllus neglectus* and recently referred by him to the synonymy under *pennsylvanicus*. It is not a distinct species, but is a very good variety. Professor Morse, of Wellesley, in conversation with the writer some months ago, said that he was informed by Doctor Scudder that, owing to the misreading of a scale, some of his, Scudder's, early descriptions contained measurements one-half too small. This quite probably explains the unusually short ovipositor and hind femora of the type of *neglectus*.

That Blatchley's *G. americanus* is a synonym of this species is quite certain. The Scudder collection contains a number of specimens referable to *neglectus* and they seem specifically similar to *americanus*, of which Professor Blatchley has kindly sent me cotypes.

GRYLLUS PERSONATUS Uhler.

Two males, seven females, Nogales, July 13 to August 3. One male, Huachuca Mountains, August 22. One female, Oracle, June 9. Two immature females, Nogales, June 17.

CECANTHUS NIGRICORNIS Walker.

Two nymphs, Huachuca Mountains, August 13 to 18.



NORTH AMERICAN PARASITIC COPEPODS BELONGING TO THE FAMILY CALIGIDÆ.

PART I.—THE CALIGINÆ.

By CHARLES BRANCH WILSON,

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INTRODUCTION.

The present is the third paper in the series based upon the collection belonging to the United States National Museum.

The other two papers treated of the Argulidæ and were published, the first in Volume XXV, and the second in Volume XXVI of these Proceedings. Acknowledgment was made in them of valuable assistance received from various sources, particularly from the United States Bureau of Fisheries. That assistance concerned the present family even more than the Argulidæ, and the author feels that any success which may have been attained in working out the habits and life histories is due almost entirely to the courtesy and assistance extended by the Bureau of Fisheries.

Additional sources of material will be found mentioned under the historical summary (p. 482).

This second family, the Caligidæ, includes about thirty genera, which separate naturally into groups differing as much in their habits as in their morphology, and thus constituting well-marked divisions. (See Key on p. 532).

The genera here treated include all of the first group, the Caliginæ, which have thus far been found in North American waters, and five species, including one which is the type of a new genus, from foreign localities. The North American species are twenty-three in number, of which thirteen are new, namely: *Caligus rufimaculatus*, *C. schistonyx*, *C. mutabilis*, *C. alivaneus*, *C. chelifer*, *C. latifrons*, *C. bonito*, *Caligodes megacephalus*, *Lepeophtheirus longipes*, *L. edwardsi*, *L. dissimulatus*, *L. parviventris*, *L. bifurcatus*.

Of the five non-American species included in the Museum collection four are new to science, namely, *Caligus teres*, from Lota, Chile; *Lepeophtheirus innominatus*, from Cornwall, England; *Lepeophtheirus*

chilensis, from Lota, Chile, and *Homoiotodes palliata*, the type of a new genus, locality unknown.

In addition to these seventeen new species the present paper gives for the first time the development stages of two species, *Caligus rapax* and *C. curtus*; almost the entire anatomy of a third, *Echetus typicus* Kröyer, while it corrects or largely supplements the anatomical details and rectifies the systematic position of seven other species, *Caligus pelamydis* Kröyer, *C. productus* Dana, *C. thymni* Dana, *Lepeophtheirus thompsoni* Baird, *L. salmonis* Kröyer, *L. pacificus* Gissler, and *Caligus centrodoni* Baird, the last a non-American species.

Here also are presented for the first time a comparative anatomy of the different species of *Caligus* and *Lepeophtheirus*, and artificial keys for the determination of all known species under the several genera. In the development are given for the first time figures of a metanuplius and the details of its anatomy. And there is introduced the first continuous life history of any species belonging to the family, together with a comparison of the life histories of several species and at least two genera.

This subfamily, the Caliginae, is particularly interesting because the genus *Caligus*, which is the type of the entire family, is one of the oldest among the parasitic copepods and formerly included many species which are now referred to other genera. Among these were some which resembled the true *Caligus* very closely, except that they lacked the lunules or sucking disks on the frontal plates. From these Van Nordmann created the genus *Lepeophtheirus* in 1832, but it was not generally accepted at first, and the species of both genera continued to be included under *Caligus* by many authors up to the appearance of Kröyer's excellent memoir in 1863.

The genus *Anuretes* also was first placed by Kollar under *Caligus* in the collection of the Vienna Museum. Like *Lepeophtheirus* it lacks the lunules on the frontal plates, and hence Kröyer, who was the first to publish a description of the species, classified it as a *Lepeophtheirus*, and it was not until 1865 that it was established as a distinct genus by Heller.

Of the other two genera, one, *Caligodes*, is simply a *Caligus* with the free segment elongated into a neck and the genital segment and abdomen modified slightly, while the appendages are identical in the two. The other genus is the new one *Homoiotodes*, and differs only in having the genital segment covered with a dorsal plate. It has not thus far been found in North American waters, but there is every probability that it will be at some future time.

These genera are very closely related to one another therefore, and since both the males and females of all except *Caligodes* can swim about freely they furnish an excellent group to contrast with the Argulidae on the one side and the Pandarinae on the other. The Argulidae are

practically nondegenerate, while the Pandarinæ are very evidently degenerate; this group therefore forms a connecting link between the two and enables us to discover and emphasize the initiatory steps in degeneration.

They thus possess the greatest possible ecological interest, and a careful study of their habits and mode of life can not fail to yield valuable facts and suggestions.

HISTORICAL.

The first accounts that can be referred to these genera with any degree of certainty, are those of Gunner (1765), Stroem (1762), and Baster (1765). They describe and figure some parasites which they call fish lice, but evidently they entirely mistook the nature of the animals, since they regarded the egg strings as antennæ and printed their figures upside down.

But the figures were accurate enough to show that these were really parasitic copepods belonging to the family under discussion. Müller in 1776 showed that these "antennæ" were egg strings, and he also found and described the true antennæ. But he blundered in regard to the eyes as badly as his predecessors had done in regard to the antennæ, mistaking for them the sucking disks on the frontal plates and failing entirely to find the true eyes. Hence he introduced his specimens under the genus name *Binoculus*, a name which survived for many years. Slabber (1778) described and pictured one of the Caliginæ under the name *Oniscus lutosus*; he also delineated the antennæ and many of the other appendages correctly and his figure is right side up. Müller in a second paper (1785) corrected his previous error by discovering that the sucking disks were not eyes. He then realized that these copepods could no longer be classed in the heterogeneous group known as *Binoculus*, and accordingly founded for them the genus *Caligus*.

But again he blundered, for the very name^a tells us that he did not find the true eyes, but considered these parasites to be blind.

Stroem (1762) was the first to study the habits of the genera from living specimens, and he has given us many interesting observations. A few additional data have been given by Leach (1813-14), Lamarek (1818), Johnston (1824), Desmarest (1825), Burmeister (1833), Rathke (1843), Baird (1850), Kröyer (1863), Heller (1865), Claus (1875), Hesse (1877, 1883), and T. Scott (1894, 1900).

But although this list of names looks quite formidable they have really given us almost nothing upon the habits and development of the group. Johnston established for the first time the external differences in the sexes of *Caligus* by describing in detail a male and a female of *Caligus curtus* from the cod.

^a *Caligus*, from caligo, a medical term for blindness or weakness of the eyes.

But the life history was so little known up to 1852 that one of the developmental stages, the chalimus stage, was regarded as an entirely distinct genus, and several species were described by various authors. F. Müller (1852) and Hesse (1877), however, explained the chalimus correctly, and recently A. Scott (1901) has given a brief life history of *Lepeophtheirus pectoralis*, in which the chalimus was still further explained. But Scott states plainly that he has not worked out the changes which take place in the developing embryo, so that we are still left with only a general knowledge of the metamorphoses and without a single authentic life history.

The work of American authors upon these genera is somewhat superior both in quality and quantity to that upon the Argulidae.

Thomas Say, in his account of the Crustacea of the United States, published in the Journal of the Academy of Natural Sciences at Philadelphia in 1818, mentions two parasitic copepods, *Pandarus sinuatus*, found on the dogfish, and another which he calls *Binoculus caudatus* on *Cullianassa*, the latter being evidently a species of *Caligus*. Following him came an admirable monograph by Dana and Pickering (1838) upon *Caligus americanus* (= *C. curtus*), which was the best account of a single species published up to that date and which remained without a rival until Scott's memoir just mentioned (1901). The subsequent American papers came at considerable intervals. Dana published several, which were entirely systematic, from 1843 to 1856. Smith in 1874 recorded all the species found in Vineyard Sound and adjacent waters, while Rathbun gave (1884) an annotated list of the species found in American waters, and in 1887 described a new species of *Trebius* from Vineyard Sound. And yet out of more than 100 species belonging to the genera here considered only 7 have been reported from North America and 6 from the West Indies. It is time, therefore, that the lists were thoroughly revised, for these parasites are as common upon the fishes of our own coast as they are in European waters.

The following account is drawn from all the sources here mentioned and many other published papers; from the records of the United States Bureau of Fisheries; from manuscript notes by R. R. Gurley on The Vermine and Crustacean Parasites of Fresh-Water Fishes; from very valuable manuscript notes and drawings by Richard Rathbun, J. H. Emerton, J. H. Blake, and S. I. Smith, all of which were kindly turned over to the author by Mr. Rathbun; and last of all from the author's own personal investigations extending over several years.

ECOLOGY.

Advancing from a study of the Argulidae to that of *Caligus* and its associates the first thing to be noted, since it is the key to most of the changes we meet, is the fact that the female of these species carries

her eggs about with her like most of the copepods. This habit necessitates several departures from the conditions found existing among the Argulidæ.

In the first place we must look for a greater difference between the sexes both in their morphology and in their habits.

The genital segment of the female is considerably larger than that of the male, and usually the first antennæ are larger and stouter. On the other hand, the second maxillipeds are larger in the male, and the abdomen is often composed of two segments, while the female has only one. The increase in the genital segment of the female, together with the heavy egg cases which she has to carry, restrict her freedom of motion.

And hence while both sexes can swim about freely it is only the males which can be expected to compare favorably with the Argulidæ in this regard. This sex difference is particularly emphasized during the breeding season or just at the time when there is the greatest incentive for free swimming. That this restriction of the female's motion is at least favorable to degeneration can not be doubted. But at the same time we have to remember that all the copepods save the Argulidæ are burdened in the same way, and yet all free-swimming forms are able to combat the condition successfully. The condition in itself, therefore, is scarcely enough to be regarded as the first step toward degeneration; we must seek something more.

In ordinary free-swimming forms the female, even when burdened with her egg strings, must move about in search of food. In fact, she needs food more then than at any other time.

Again, in the Argulidæ, the female deposits her eggs upon some convenient surface away from the body of her host, and such deposition becomes not an incentive merely, but an imperative demand for free swimming. The males follow the females at these times and also search for them from fish to fish.

Caligus females, on the contrary (and the same applies to all parasitic genera), carrying their eggs about until they hatch, find the surface of the fish's body one of the best possible positions to secure good aeration for the eggs and to discharge the nauplii when they are sufficiently matured.

Finally these parasites feed upon the blood of their host, or at least upon something which they obtain while upon the host's body; hence by remaining here they are nearest the source of their food supply. In short, all the incentives are for remaining, rather than leaving the host and swimming about, and adult females almost always remain upon the fish, even during the periods when they are without egg strings.

The only inducement in these forms to free swimming on the part of the female would be that which is common to all parasites, plant

and animal alike, namely, the original search for a suitable host. But this operates in developmental rather than in adult stages, and it is a significant fact in this connection that nearly every female of these genera which has been captured in the tow has been immature.

The mechanical hindrance afforded by the egg-strings, together with the strong incentives just enumerated for remaining upon the body of the host, may be fairly considered as constituting the first step toward degeneration. Let us now look at the mode of locomotion in these genera in order to discover the second step.

LOCOMOTION.

There are two modes of locomotion as in the Argulidæ, a free-swimming and a scuttling motion. The presence or absence of the latter has a greater significance than has hitherto been accorded to it. By watching specimens of *Argulus* and *Caligus* in an aquarium it can be seen that the latter are really the better swimmers. This is due to the increased surface of the first three pairs of legs, particularly to the large lamina or apron which connects the third pair across the ventral surface of the body. These legs furnish a swimming organ which propels the copepod through the water with strong and swift movements. Often the motion is so erratic and persistent that the animals seem to have fairly gone mad, dashing frantically about, turning summersaults, rushing for a distance along the sides of the aquarium, or scuttling back downward across the under side of the surface film of the water. Equipped with such a swimming apparatus it would naturally be supposed that they would put it to frequent use, but we have already seen that they lack the incentive. As a matter of fact, mature females of but one or two species have ever been taken with the males at the surface.

Furthermore, as will appear in the descriptions which follow, these few specimens were all of the genus *Caligus*, the species *rapax* being most commonly secured. The other genera here treated do not show as much inclination to free swimming as *Caligus* and there are but one or two very doubtful records of their capture in the tow. Indeed, A. Scott goes so far as to conclude from a series of careful investigations that "*Lepeophtheirus* throughout the remainder of its life and under normal conditions remains on the same fish that it attached itself to at the beginning of the chalimus stage." And the same might probably be said with regard to *Anuretes* and *Trebius*.

When we consider the amount of surface towing conducted every year under the auspices of the United States Bureau of Fisheries, the scarcity of these parasitic forms can only mean that at least the mature females are not accustomed to swim freely at the surface, but only do so under extreme provocation.

Such a change in habits, constituting as it does a long step toward that fixedness of position which precedes radical degeneration, must have some adequate cause. These three genera have practically the same swimming apparatus as *Caligus*, and if it is never used there must be some preventive influence which operates in their case but not in that of *Caligus*.

In the author's opinion this influence may be found in the presence of sucking disks on the frontal plates of *Caligus* and their entire absence in the other genera. Their presence gives to *Caligus* the same scuttling motion as *Argulus* obtains from its first maxillipeds. In this way they move about over the surface of their hosts with great rapidity and upon the slightest provocation. But the other genera, lacking the sucking disks, are dependent upon the second antennæ and the maxillipeds for locomotion over the surface, and can not consequently move about with any rapidity. For this reason they do not change their position as often as *Caligus* but remain a long time fixed in one place. Indeed, when an attempt is made to remove them from their host, only the males and immature females move about in order to escape. The mature females usually settle down *in situ* and only cling the more tightly. When removed from their hosts and placed in aquaria these genera settle upon the bottom or sides and remain stationary for long periods, in marked contrast to the restless activity of *Caligus*. This fixity of position can not help reacting unfavorably upon any tendency toward free swimming which might still be retained by the copepod.

To recapitulate, then, we find that none of the Argulidæ exhibit degeneration or even any tendency toward it. They have all retained completely both the ability and the inclination to swim freely and to move about over the body of their host.

Among the Caliginæ the genus *Caligus* possesses even more ability than *Argulus*, and the males and immature females retain practically the same incentives. But for the mature females every influence operates toward remaining upon their host, and they are very seldom captured swimming freely. All the species of *Caligus*, however, still move about over their host's body upon the slightest provocation. Other genera, being destitute of lunules, lack the ability to move about on the body of their host with any freedom.

This acts as a still stronger damper upon their movements, and although they retain fully the ability to swim they almost never exercise it. They not only remain upon one host all their lives, but they also fasten themselves in a single spot and stay there continuously. They thus exhibit the initial stages of degeneration, whose next step is to be a partial loss of the ability left unused.

While speaking of locomotion mention must be made of a pernicious habit common to many of the Caliginæ. This consists in crawling up

the sides of the dish or aquarium as far as possible above the surface of the water and remaining there till thoroughly dried, and, of course, dead and worthless. For this reason it is very difficult to keep such species alive for any length of time. Even to carry them from the collecting ground to the laboratory, or to keep them alive while being examined, it is necessary to carefully stopper the bottle or to cover the dish, so that the air above the water shall be so saturated with moisture that the copepods can not dry in it.

Fortunately this disagreeable habit is practically confined to the genus *Caligus*, and the other genera make quite tractable subjects for aquaria. This is particularly the case with *Lepeophtheirus*, and A. Scott states that *L. pectoralis* may be kept alive "in sea water for upward of six weeks after removal from the fish."

PREHENSION.

The organs of prehension include both sucking disks and claws; the former are confined to a few genera; the latter are common to all the genera. The arched carapace, also, in all the genera, acts as a large sucking disk, its margin being pressed close to the surface, and the contact sealed with water and slime. This constitutes a secondary organ of prehension, vastly more effective than in the Argulidæ, since its margin is made continuous posteriorly by the broad lamina connecting the third swimming legs. When flattened against a surface by muscular contraction and then released it works very powerfully.

The claws constitute the terminal joints of the second antennæ and the second maxillipeds, the entire joint functioning and being capable of strong flexure upon the basal joint.

It seems probable that these different organs of prehension are used in different localities upon the fish's body. The lunules and the suction of the carapace afford the principal means of prehension on those portions of the outside surface of the host which are covered with scales. There is an integument over the scales, to be sure, and in many of the fish which serve as hosts the scales have small spines upon their free surfaces. But the integument is so thin and the spines are so small and weak that they afford but a feeble hold for claws. There is no chance to bury the claws sufficiently to withstand the ordinary friction of water, to say nothing of that of sand or mud, which must be overcome on the ventral surface of such fish as the flounder, skate, etc. The fins, on the other hand, have no scales and the covering integument is firmer and thicker, and affords an admirable material in which the claws may fully bury themselves. So that although the tail and other fins must, from their movements, subject the parasites to considerable additional friction, this is more than counterbalanced by the superior hold which they afford. The blood vessels also are more

easily accessible in the fins than under the scales. These two reasons are sufficient to explain the preference of copepod parasites for such localities.

It might be inferred that in those genera which are destitute of lunules there would be a somewhat stronger development of the claws. Possibly they are a little larger and stouter, but the difference is very slight, and after careful examination it does not seem sufficient to warrant any statement.

This method of prehension by claws renders it more difficult to remove the parasite from its host. *Caligus* comes off easily, but it takes a decided pull to loosen one of the other genera, and often the posterior part of the body will be torn away from the anterior without weakening the hold, as noted by Scott.

Long experience has taught that the best way to remove these parasites intact is to slip one end of a pair of broad-tipped forceps well under the carapace and lift the copepod off quickly as one would a limpet.

Connected with prehension are the various devices to prevent slipping backward upon the fish's body. We miss in this group the spines upon the ventral surface of the carapace and the roughened plate with its posterior teeth on the basal joint of the second maxilliped, which were so common amongst the Argulidæ.

But we find instead a small plate that often bears spines upon the basal joint of the first swimming legs, and a sternal fork. The broad lamina joining the third legs also, when applied closely to the surface, must act as a powerful preventative to slipping. And these creatures need something that is powerful for they are often found upon the ventral surface of such fish as the flounder, halibut, plaice, and skate which frequent the bottom and often bury themselves entirely in the sand or mud.

The friction at such times must be very great and tax to the utmost both the flattened form and the prehensile powers of the parasites.

HOSTS.

In general the Pleuronectidæ and Gadidæ are the most frequent hosts of the Caligids, but many widely divergent families and genera are represented in the host list. They may be found anywhere upon the external surface or in the gill cavity of their host, while a few species are commonly found inside the mouth, the most notable instance being the new species of *Caligus* from the Bonito. On the outer surface they often prefer the fins, especially the pectorals since these furnish good opportunities for attachment and food as already explained. And then as the parasite usually seeks the underside of the fin it must also be protected in great measure by the latter from the friction of the water or mud through which the fish is passing.

Many species show a tendency to congregate in certain places to the almost entire exclusion of the rest of the fish's body, as in the case of *Caligus bonito* and *Lepeophtheirus pectoralis*.

While many of the species stick to one particular host there are others which change hosts from time to time and which are able like the Argulidae to live temporarily upon almost any fish that may be available. *Caligus rapax* easily takes the lead in this, having been found upon twenty-five or thirty different fish. A few of these like the flounder and cod are regular hosts, and an examination of a very few fish is almost certain to reveal the presence of this parasite. At the right seasons also the chalimus stages of development may be found attached to the fins and scales of the same fish. But for the other hosts there is often a record of only a single specimen which was evidently a straggler and took that particular fish until it could find something better.

FOOD.

These parasites feed upon the blood of their hosts which they obtain in the same manner as did the Argulids by burrowing under the scales or piercing the skin on the fins with their maxillipeds and proboscis. This blood, filling the central digestive system, may often be seen as a dark streak through the body, and is sometimes very prominent in transparent specimens.

When taken from the fish those specimens usually live the longest which have the most blood in them; the latter seems to digest slowly and may often be seen for several days in the intestine.

Many authors write that these parasites, or some of them at least, feed upon the mucus of the fish's body and that no blood has ever been found in their stomachs.

This statement seems to rest entirely upon the fact that no red color can be seen in their digestive organs. A. Scott says of *Lepeophtheirus pectoralis*, "when taken directly from the living fish and placed under the microscope it rarely shows even the faintest trace of red coloring matter in the alimentary canal."

But the same author concludes on the next page that this species feeds to some extent on blood, and a little later he adds "they do not hesitate to eat their comrades when these become feeble." For animals which will do this mucus must be a rather tame and inadequate food.

It is difficult to determine what the food really is, but there are several considerations which will help us to form a rational judgment in the matter. In the first place, it makes a difference what part of the fish's body the parasite is taken from, whether it shows any red in the digestive organs or not.

If taken from the gill cavity the red is nearly always prominent, while it seldom appears in those individuals taken from the outside of the body. Some species are always found in the gill cavity and they

always show blood in the alimentary canal. Other species are always found on the outside of the body and they are the so-called mucus eaters. But there are still other species, like *Caligus rapax*, which may be found in either place, and in them we find the same difference.

In explanation we must remember two facts: The gill cavity is the easiest place to get blood on the fish's body, and it is very possible that such a species as *C. rapax* may slip into this cavity to get its food and then slip out again to the exterior of the body. Consequently when taken in the gill cavity it would have just finished eating, while on the outer surface of the body the blood may have had time to partially digest.

The second fact is that all these genera are supplied with powerful digestive glands unlike the Lerneans. We shall see later (p. 513) that one pair of these glands are situated in the anterior part of the carapace and pour their fluid upon the food as soon as it strikes the stomach. Only freshly aerated blood, in or near the fish's gills, has a deep red color; that in the capillaries of the skin and fins is not very red when swallowed. Hence it would not take very much of a digestive fluid to remove the color entirely.

It is very suggestive to note in this connection that the adult Lerneans, in which the food is so red as to leave no doubt of its nature, have no digestive glands. During development, however, there is a digestive gland, and the contents of the alimentary canal are not red. It is scarcely possible that the young Lernean eats mucus while the adult eats blood.

Again, if these creatures are seeking mucus for food why do they not choose such fish as are most bountifully supplied with it? And how does it happen that they always hunt out those places upon the fish's body where the skin is unprotected and the thinnest? There is more mucus on the scales than anywhere else; why should they choose the fins or the inside of the operculum? Finally, the mouth parts of species, which it is claimed eat mucus, are similar in every particular to those of species which are acknowledged blood-suckers. The eating of mucus, then, must be an acquired taste, and it is difficult to understand how an animal with its mouth parts fitted for sucking blood should be content to merely sip mucus while it still retains enough of its old blood-sucking habits to choose the places on the fish's body best adapted for that purpose.

These parasites are very susceptible to any increase in temperature, and a rise of a few degrees will speedily prove fatal.

This is the chief source of difficulty in keeping them alive in aquaria. A. Scott gives 16° C. as the limit for *Lepeophtheirus pectoralis*, and experiment has shown that other species do not differ much from this. A general average of all the species experimented with would raise this limit slightly, to 18° or 20° C.

On the contrary, they can withstand a very great decrease in temperature. Scott states that the aquaria containing *Lepeophtheirus pectoralis* were frozen several times without injury to the parasites. Although this experiment has not been tried upon other species, there is no reason to doubt that they could withstand as severe cold. Repeated trials have shown that the best way to keep these creatures alive for any length of time, particularly during hot weather, is to pack the aquarium or bottle in ice. Those species which are otherwise prone to crawl up out of the water are much less likely to do so, but seem content to remain beneath the surface. Possibly this disagreeable habit may be connected ordinarily with a rise in temperature of the water in the aquarium.

SUMMARY.

1. The females of the genera here discussed carry their eggs about with them. This necessarily restricts their freedom of motion, but not to a greater extent than in free-swimming forms.

2. Added to the restriction, however, is a lack of incentive to free swimming, since the parasite obtains its food upon its host and finds there the best position for the aeration of its eggs.

These two conditions combined constitute the first step toward degeneration.

3. These genera are really better swimmers than the Argulidæ, owing to the increased surface of their swimming legs, particularly the third pair. But they do not exercise this ability nearly as often as the Argulidæ, for the reasons just stated.

4. In addition to their free swimming, the *Caligus* species also exhibit the same scuttling motion as the Argulidæ, and it is accomplished in a similar manner by means of the sucking disks on the frontal plates.

5. In other genera the sucking disks are absent, the scuttling motion is impossible, and we find still less of an inclination for free swimming. Careful observations indicate that these genera remain throughout life upon the same fish to which they attached themselves in the chalimus stage.

6. As another consequence of the loss of the scuttling motion they remain for long periods in the same position upon their host, moving only upon strong provocation. This fixity of position constitutes a second step toward degeneration.

7. For prehension we find the sucking disks in *Caligus*, and stout claws upon the second antennæ and the second maxillipeds in all genera. The edge of the carapace also, supplemented by the broad lamina connecting the third swimming legs, is flattened against the supporting surface and functions as a large sucking disk.

8. To prevent slipping backward under friction there are weak spines upon the bases of the first swimming legs, and a stout sternal

fork between the bases of the second maxillipeds. The lamina of the third swimming legs also renders effective service in this direction.

9. These genera show a decided preference for the Pleuronectidæ, and the Gadidæ as hosts, but such of them as practice free swimming may be found upon almost any host temporarily. Many of the species, so far as observed, are confined to a single host.

10. These parasites feed upon the blood of their host in a similar manner to the Argulidæ. They are very susceptible to heat, and an increase of temperature of only a few degrees is quickly fatal. On the contrary, they can withstand very severe cold, even freezing, without apparent injury.

MORPHOLOGY.

A. *External*.—The types upon which Müller founded his genus *Caligus* in 1785 included several genera beside the true *Caligus*. Indeed, the only species amongst his types really belonging to the genus was *Caligus curtus*. Hence his genus diagnosis was very broad and would have included practically all our North American Caliginæ. In the present morphology the statements have been made equally inclusive and are to be understood as embracing all North American Caliginæ unless otherwise limited. The body of a *Caligus* is made up of four parts or sections, a cephalo-thorax, a free thorax, a genital segment, and an abdomen. The cephalon bears seven pairs of appendages, namely, antennules, antennæ, mandibles, first and second maxillæ, and first and second maxillipeds. The three anterior thoracic segments are fused with the cephalon so that the cephalo-thorax bears three pairs of swimming legs in addition to the appendages just enumerated. The free thorax consists of a small segment carrying the fourth pair of swimming legs and the genital or reproductive segment. The latter has in both sexes a pair of appendages which in the male are very evidently rudimentary swimming legs of the fifth pair. In the female they are often so reduced as to be recognized with difficulty, but their presence is sufficient to show that this segment must be regarded as a portion of the thorax if we are to be consistent in our nomenclature of the crustacea. Hence, while retaining the designation "genital segment," already in general use, it will be understood that this is really the fifth thoracic segment, the second free one. It varies greatly in shape in different species, in different stages of development in the same species, and in the two sexes. In the male and in immature females it is always smaller and often approximates the abdomen closely in size. But as the female approaches maturity it increases greatly and becomes usually much larger than the abdomen.

Furthermore, in undeveloped forms of both sexes the rudimentary fifth legs are relatively much larger than in the mature individual, and may commonly be seen as a pair of large lobes or processes clearly

differentiated from the remainder of the genital segment (5, fig. 1). As development progresses these lobes become assimilated more and more with the body of the segment, until at the last they are oftentimes invisible except from the ventral surface, and then only after careful examination.

Owing to this extreme variation in size and shape the greatest care must be exercised in comparing different specimens for purposes of classification. The individuals compared must be alike in sex, in maturity, and even in the period of pregnancy if the size or shape of the genital segment is to have its full significance. Fortunately, one breeding season follows another so rapidly that the female is never

left for any long interval without her eggstrings. Hence, in collecting these parasites, fully ripe females are very largely predominant. On being preserved the egg cases become very brittle and break off easily, but examination will quickly reveal the fact that they have been present, which of course is all that is required. In the Key which is given later (see p. 555) the shape of the genital segment is made one of the final means of determination after the other more important ones have been exhausted, and even then it must not be given too much prominence.

The length of the egg strings and the size of the eggs vary greatly in different species and in different individuals of the same species, and the best that can be done is to give the general average. The size of the eggs is always a better guide than the number.

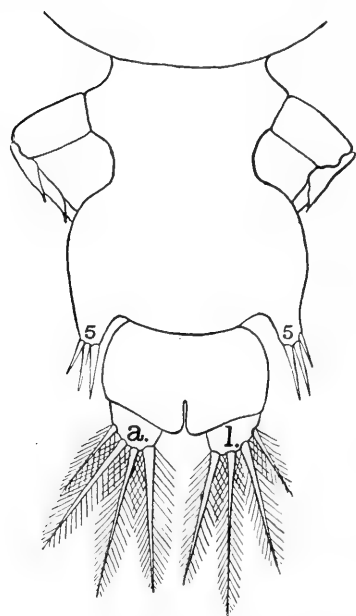


FIG. 1.—YOUNG FEMALE OF *LEPEOPHTHEIRUS EDWARDSI*, SHOWING THE FIFTH PAIR OF SWIMMING LEGS AT THE POSTERIOR CORNERS OF THE GENITAL SEGMENT. *a.*, ANAL LAMINÆ; 5, RUDIMENTARY FIFTH LEGS.

Like the genital segment, the abdomen is usually simple, but sometimes two-jointed, this condition occurring more frequently in the male. There are two species of *Caligus* also in which it is three-jointed, *C. coryphænx* and *C. angustatus*, and another in which it is four-jointed, *C. aliuncus*. (See Plates VII and IX.)

The abdomen is terminated by two processes, one on either side of the anus, and each furnished with three or four plumose setæ (a. 1, fig. 1). These processes have been given different names by different authors. Milne Edwards calls them "lames caudales;" Krøyer designates them as "halevedhaengene" in Danish, while in his Latin diagnoses they are simply "appendices;" Heller speaks of them as

"Schwanzanhänge," in his Latin diagnoses as "appendices caudales;" Claus calls them "Furcalanhänge," in Latin "foliola caudalia;" Gerstaecker designates them as "Endgabel (Furca);" while Bassett-Smith speaks of them as "caudal plates."

There are several objections to these names. In the first place, most of them preserve in some form the old name of "tail," given to the abdomen, which was entirely a misnomer.

The use of "furca" or "fork" is even worse, for we already have a furca upon the ventral surface of the carapace, and the repetition of the name for a very different appendage could not but breed confusion. Why not apply to them the term "anal," since they are always situated beside the anus, and thus get a term to which there could be no objection as a misnomer and which would be free from any danger of confusion? Let us call them, then, anal plates or laminae, as we called the appendages in the Argulidae, similar in position but different in shape, anal papillae.

There is thus a cephalon bearing seven pairs of appendages, a thorax of five segments, each bearing a single pair of appendages, the first three united with the cephalon, and an abdomen of from one to four segments, the last of which bears the paired anal laminae.

The cephalo-thorax is strongly flattened dorso-ventrally and is covered with a hard shell or carapace, which serves to protect the softer parts underneath. In structure this shell is like that which covers the anterior portion of the body in the Argulidae, but its shape is considerably different.

In the first place, the anterior antennae, instead of being concealed beneath the carapace, form a wide articulated border across its anterior margin, their free ends standing out prominently on either side. In six genera—*Caligus*, *Pseudocaligus*, *Caligodes*, *Synestius*, *Homoiotes*, and *Parapetalus*—the frontal plates thus formed carry upon their anterior margins sucking disks or lunules. In the other genera they are perfectly plain.

These lunules often stand out prominently and, with the plates themselves, give a squared appearance to the anterior margin (Plates V, VI, XII). This is usually increased by an incision at the center where the two plates meet, or by an emargination extending for some distance on either side. In rare instances just the reverse takes place, and the frontal margin is made pointed by a protrusion of the plates between the lunules in the form of a beak or rostrum (*Caligus haemulonis*, *irritans*, and *murrayanus*). Either form presents a sharp contrast with the evenly rounded anterior margin in *Argulus*.

Again, instead of a single median posterior sinus, there are two, one on either side, leaving a median lobe between them, which is usually half the entire width or more.

But the regions of the cephalo-thorax are practically the same and are very similarly arranged in the two.

As boundaries of these regions we find grooves similar to those in the Argulidæ but differently arranged, not merely in the different genera, but in different species as well.

In general they may be described as follows: A pair of longitudinal grooves, one on either side of the mid-line, more or less parallel with it and removed some distance from it, correspond with the sides of the horseshoe suture in the Argulidæ.

But they extend backward farther, reaching the posterior margin of the lateral lobes, while they do not reach forward to the frontal margin. They form the sides of a large letter H and are connected by the third groove transversely at or just posterior to the center of the carapace (fig. 2). The carapace is hinged along these sutures and capable of some motion upon them, as in the Argulidæ. On the outside of the lateral grooves are the lateral areas, extending back in a lobe on either side of the carapace much narrower than in *Argulus* (L. A.).

The transverse suture marks the juncture of the head and thorax so that the central region in front of it is the cephalic area (C. A.), while behind it is the thoracic area (T. A.), the former being usually the larger. These three grooves are present in practically all the genera and species. In addition there are others which occur with more or less frequency. One of these is a horseshoe-shaped groove extending from the suture between the carapace and the frontal plates backward around the eyes.

It is similar in shape to that in the Argulidæ, but as the eyes in the two families are entirely different it does not correspond in morphological significance.

There are also grooves at the bases of the free portions of the first antennæ which extend inward on the carapace for a short distance, while others appear often in the anterior portion of the lateral areas.

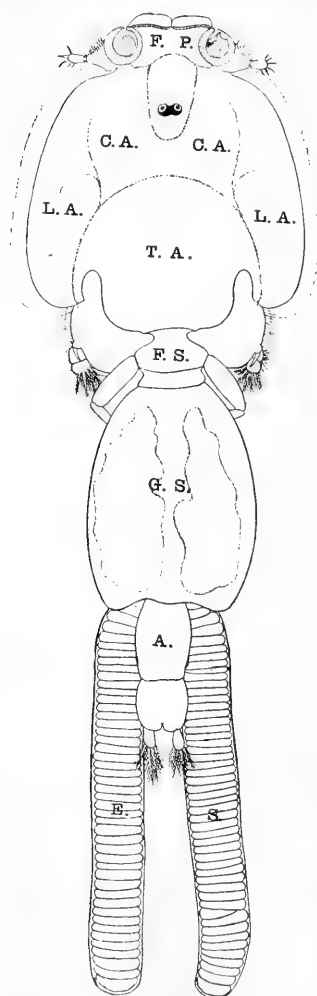


FIG. 2.—ADULT FEMALE OF *CALIGUS MUTABILIS*, SHOWING THE BODY REGIONS AND THE AREAS OF THE CARAPACE. A., ABDOMEN; C. A., CEPHALIC AREA; E. S., EGG-STRINGS; F. P., FRONTAL PLATES; F. S., FREE THORACIC SEGMENT; G. S., GENITAL SEGMENT; L. A., LATERAL AREAS; T. A., THORACIC AREA.

Rarely a second transverse groove is found in front of the crossbar of the H as in *Caligus hæmulonis* and *C. aliuncus* and in *Gloiopotes ornatus* (See Plates IX, XVIII, XIX, XXIII).

The frontal plates (F. P.) are separated from the carapace in all the genera here considered by an irregular groove made up of several symmetrically arranged curves.

These frontal plates are really the basal joints of the first antennæ, as can be readily seen in following the development, and they thus correspond in function to the hooked claws on the base of the first antennæ of the Argulidæ.

The two plates do not quite meet at the center, but are separated anteriorly by a deep and very narrow sinus which marks the former position of the filament for attachment in the chalimus stage, and by a slight projection of the carapace from which this filament emerged. On the ventral surface at the base of the suture there is an oval opening surrounded by a narrow fringe of chitin. This represents the median sucker which is considerably developed and forms an important organ of adhesion in the early chalimus stages (s. fig. 3). Its usefulness is almost entirely superseded in the adult *Caligus* by the sucking disks which develop during the later chalimus stages, but in the other genera it may serve as a "first aid in securing the animal to its host," as suggested by A. Scott (1901).

In favorable specimens a chitinous rod (f. f.) can be seen passing back from this sucker toward the eyes. This rod is the remains of the filament, and at its inner end may be seen the gland which secreted the substance of the filament.

The sucking disks, which in *Caligus* serve both for prehension and locomotion, are of peculiar construction, resembling not the body or basal portion of the sucking disks in *Argulus*, but rather the free membranous border. They consist of a short and rather flat cone of membrane, often split for a considerable distance down the ventral or anterior side.

This suture is often so wide that a cross section would take the form of a horseshoe rather than a circle. The membrane is supported by a very few transverse and by many longitudinal ribs of chitin, all of which, however, are simple hairs or threads and not the complicated affairs found in the Argulidæ.

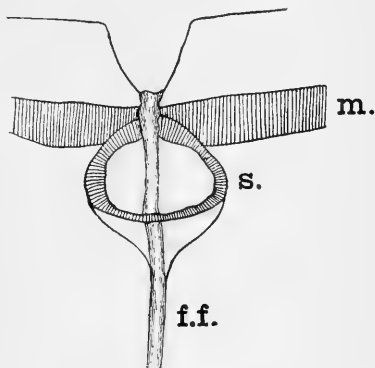


FIG. 3.—THE MEDIAN SUCKER OF CALIGUS RAPAX. f. f., FRONTAL FILAMENT; m., ANTERIOR MARGIN OF FRONTAL PLATES; s., SUCKER.

This cone is often partially or even almost completely concealed by the border of the frontal plate in a dorsal view, so that it is only by turning the animal over on its back that one could be sure whether it has lunules or not. This is the condition with the entire genera *Caligodes*, *Synesthius*, and *Parapetalus*, and rarely in some species of *Caligus* like *C. diaphanus*.

The carapace, like all the rest of the body, is covered on both the dorsal and ventral surfaces by a thin cuticle. At the margin where these two cuticles come together they are fused and form a wide, perfectly transparent border along the frontal and lateral edges. Being smooth and flexible this border can be applied very closely to the supporting surface and forms thereby a tight joint which greatly aids in prehension, as already noted (p. 486).

The eyes are situated on the median line, about one-third the distance from the front of the carapace. They are two in number, so closely approximated as to be partially flattened, and are embedded in a mass of pigment which lies wholly beneath the carapace. Each consists of a spherical mass of pigment flattened on the inner side, where it is separated from its fellow by a thin layer of chitin, lined with the same pigment.

The lens is spherical and projects about half its diameter from the outer or anterior margin. Behind the lens is a retina made up of a single row of relatively large cells, which are lined on the inner side with a layer of pigment. This pigment is usually black or very dark wine-red in color, while the lens is colorless and perfectly transparent.

In quite a number of species, scattered through all the different genera, the eyes are invisible (in preserved specimens) to even the most careful scrutiny. But it seems probable that they are merely concealed by overlying pigment and not really lacking. This point can be determined only by a study of sections which are not at present available.

From a study of the early development we find that these eyes are originally placed much farther back in the carapace and are separated by a greater distance from each other, and that they afterward migrate forward and inward toward the mid line, until they are so thoroughly fused as to appear as one eye with two lenses.

The free thoracic segment is small in nearly all the species; it represents the fourth thoracic segment of free-swimming copepods and carries the fourth pair of swimming legs attached to its outer margins (F. S. fig. 2). In all the species figured, with one or two doubtful exceptions (*C. dubius* and *C. fallax*), it is so much narrower than the carapace and genital segment, especially where it joins the former, as to appear like a wasp waist connecting the two. This appearance is heightened in *Caligodes* by a considerable lengthening of the segment. The rare instances in which it is figured as double instead of

single (*Caligus alalongæ*, *chorinemi*, *productus*, *robustus*, and *trachypeteri*) are very doubtful and the probability is strongly against them.

For instance, while Krøyer's smaller figure of *C. productus* shows two segments, Dana's enlarged figure of the genital segment of the same species shows also the free segment as single. In several species (*Caligus irritans*, *monacanthi*, and *vexator*) the sides of this segment are indented as if for another joint, but there is no actual division and the cases just mentioned are probably the same.

Indeed, if these or any other species really had two free segments, this would be sufficient ground for a generic rather than a specific distinction.

The genital segment (G. S. fig. 2) is not, as its name would imply, the seat of the reproductive organs proper, but merely of the ducts leading from them, in the female the internal oviduct, and in the male the vas deferens and the spermatophores (see figs. 32, 33, 34).

But since in the female the convolutions of the oviduct contained within the genital segment are the place where most of the development of the egg occurs, it follows that this segment is usually plump and swollen. Its shape varies greatly and is indicated for each of the different species in the keys on pages 555 and 615. In many of the species the walls are so transparent that the structure of the internal organs may be conveniently studied through them.

The abdomen (A. fig. 2) is always narrower than the genital segment (except in *Caligus hirsutus*), often markedly so, and is usually shorter and simple. In certain species, however, it is much longer (*Caligus macrurus*, *pelamydis*, *scomberi*, and *stromatei*), and it is also sometimes segmented, this occurring oftener in males than in females. And then the abdomen in the male is relatively longer than in the female, so as to give this sex a narrowed, drawn-out appearance, contrasting strongly with the plump, stocky figure of the female. The external egg cases (E. S. fig. 2) are cylindrical tubes, the substance of which is secreted by a shell gland situated in the genital segment and opening into the internal oviduct very near its exit from the segment. The cylinder is divided into segments by cross partitions, one between every two eggs, so that often when the nauplii have escaped from the eggs there is left behind a sort of moulted skin which retains the exact form of the original, but is entirely empty. When full these egg cases are the most potent influence to check the ability of the female to move about freely. Oftentimes they are relatively very large, and in one species, *Caligus diaphanus*, the two strings taken together are nearly as large as the entire body.

There are twelve pairs of appendages, namely, two pairs of antennæ, one pair of mandibles, two pairs of maxillæ, two pairs of maxillipeds, and five pairs of swimming legs, all on the ventral surface except the

first antennæ (an', fig. 4). These latter are attached to the frontal margin of the carapace and project sideways from the body. Each is made up of three joints; the basal joint is the largest and is in the form of a lamina or plate, which bears a lunule on its margin. The median joint is larger than the terminal and bears tactile plumose setæ on its anterior and outer margins. The terminal joint is usually more or

less club-shaped and furnished with short and sharp spines at and near its tip. These antennæ should be very highly sensitive, if their innervation is any criterion, for a large nerve enters each from the supra-cesophageal ganglion, and, dividing and subdividing, sends a branch to the sucking disk of the basal joint, to each plumose seta of the median joint, and each spine of the distal joint.

The second antennæ (an'') are attached to the ventral surface just posterior to the bases of the first. They are each two-jointed, the basal joint being short and stout and plentifully supplied with strong muscles. The apical joint is modified into a stout prehensile claw, which fits into a cup or socket hollowed out of the ventral surface of the carapace near its front margin. In the genera under discussion these antennæ have become entirely prehensile in function, and, with the second maxillipeds, they are the chief organs of attachment in places where the skin is accessible (fig. 5).

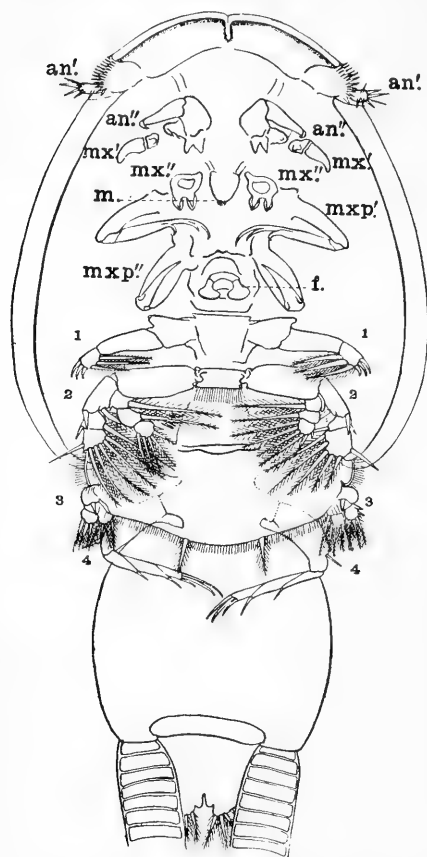


FIG. 4a.—VENTRAL SURFACE AND APPENDAGES OF AN ADULT FEMALE *LEPEOPHTHEIRUS EDWARDSI*. an', FIRST ANTENNÆ; an'', SECOND ANTENNÆ; f., FURCA; m., MOUTH; mx', FIRST MAXILLÆ; mx'', SECOND MAXILLÆ; mxp', FIRST MAXILLIPEDS; mxp'', SECOND MAXILLIPEDS; 1, 2, 3, AND 4, SWIMMING LEGS.

The mandibles are wholly inclosed within the mouth tube; they are very slender, stylet-shaped and usually four-jointed.

The apical joints are visible through the mouth opening; they curve in toward each other and are either serrated or crenated along their inner edges, the number of teeth being twelve to sixteen.

In *Lepeophtheirus* the outer margins are smooth, but in *Caligus* they are sometimes cut into very small acute teeth, eighteen to

twenty in number (fig. 6). The bases of the mandibles are attached just inside the lateral chitin rods of the lower lip, and are connected with the ventral surface of the carapace by stout muscles. There are no traces of mandibular palps.

The first maxillæ (mx', figs. 4 and 5) are situated near the lateral margin of the carapace, just outside of, and a little posterior to, the bases of the second antennæ. Each consists of a single joint in most of the species, but of two joints in a few species of *Caligus* according to the descriptions given. In both sexes they are swollen at the base and taper toward the tip; in the female they are short and blunt and apparently of no service.

In the male they are much longer and taper to a slender, sharp point at the apex; each maxilla is also curved over toward its fellow on the opposite side and thus forms a claw similar to that on one of the second antennæ (fig 5). And their function would seem to be similar, although we must remember that they are shorter and weaker than both the second antennæ and the second maxillipeds and so could not reach the host's body until after these others had been buried in the skin. Possibly they may serve in both sexes to irritate the wound and so stimulate the flow of blood. In some species of *Caligus* and *Lepeophtheirus* two minute setæ are attached to the basal part of each maxilla which A. Scott considers to represent the exopodite or palp (e', fig. 7).

The second maxillæ (mx'', fig. 4) are placed at the sides of the mouth just outside of the suctorial tube. Each is made up of a single joint, stout at the base and slender toward the tip.

In *Caligus* and closely allied genera the terminal portion is undivided while in *Lepeophtheirus* and its near relatives it is bifurcated.

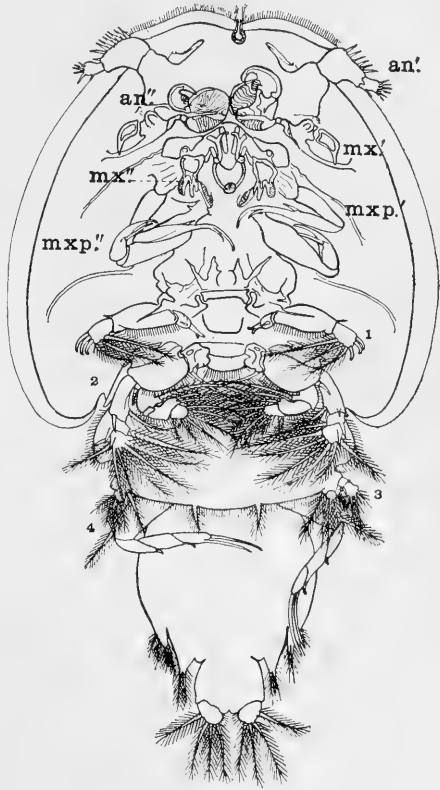


FIG. 4b.—VENTRAL SURFACE AND APPENDAGES OF AN ADULT MALE *LEPEOPHTHEIRUS EDWARDSI*. (For lettering see Fig. 4a.)

This terminal portion represents the exopod and in many species of both *Caligus* and *Lepeophtheirus* there is also a distinct endopod (e", fig. 7), with two setae on its apex attached to the base of the exopod (*Lepeophtheirus pectoralis*, *Caligus rapax*, etc.).

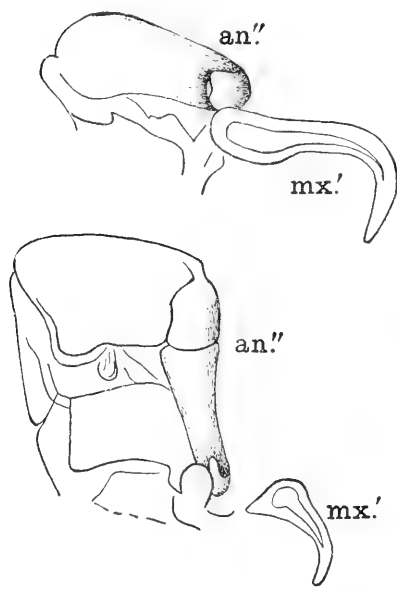


FIG. 5.—THE SECOND ANTENNAE AND THE FIRST MAXILLAE OF THE ADULT *CALIGUS BONITO*. UPPER FIGURE, THE MALE; LOWER, THE FEMALE.

The mouth opening is terminal or termino-ventral and may be either circular in outline (*Caligus bonito*, *Lepeophtheirus edwardsi*), transversely elliptical (*Caligus rapax*), or even strongly lunate (*Caligus curtus*, *Lepeophtheirus pectoralis*).

Whatever its shape it is always surrounded by a fringe of long hairs. Often in the incision at the center of the under lip is a small tuft of hairs considerably longer yet. In living specimens these hairs are seen to be motile and they must assist in drawing the blood up the mouth tube by making the joint at the mouth opening tighter.

The framework of the mouth is quite complicated and consists of two sets or series of rods running lengthwise, connected by others

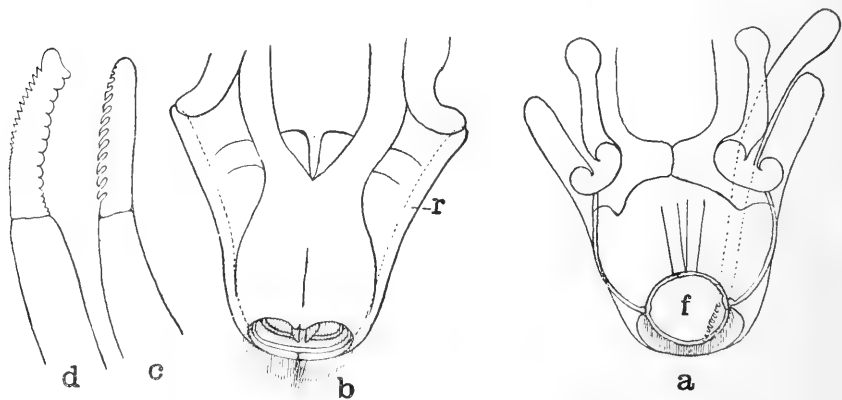


FIG. 6.—MOUTH PARTS. a, DORSAL SURFACE OF MOUTH TUBE OF *LEPEOPHTHEIRUS HIPPOGLOSSI*; b, VENTRAL SURFACE; c, MANDIBLE; d, MANDIBLE OF *CALIGUS BONITO*; f, FLEXIBLE FLAP AT ANTERIOR END OF UPPER LIP; r, ROD ON LATERAL MARGIN OF FRAMEWORK OF LOWER LIP.

which are transverse. There is first a long rod on either side, running the entire length of the framework along the lateral margins and furnishing the requisite support for the whole mass (r, fig. 6, and r',

fig. 10). These rods are inclined toward each other as they proceed away from the ventral surface; their proximal ends are bent sharply and sometimes carried a short distance along the ventral surface of the carapace as in *Caligus curtus*. They are articulated at the bend thus made and again near the tip, making them three jointed. At the basal joint they are also articulated with the ventral surface of the carapace, and the muscles which elevate or lower the whole mass are fastened here.

The short terminal joints curve inward and nearly meet at the mid line (*Caligus bonito*, *Lepeophtheirus edwardsi*). Sometimes they are reenforced here at the tip by other small rods which run in toward the

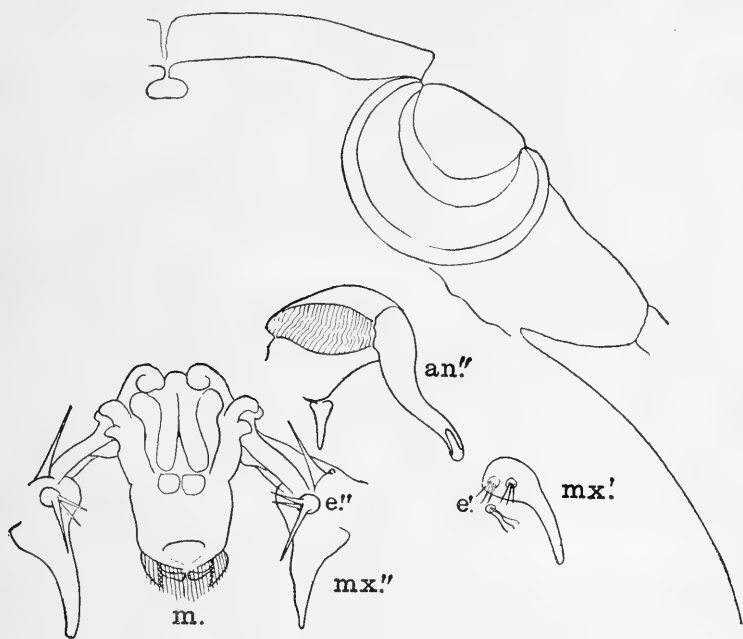


FIG. 7.—SECOND ANTENNAE, FIRST AND SECOND MAXILLE AND MOUTH TUBE OF ADULT *CALIGUS RAPAX*. HIGHLY MAGNIFIED TO SHOW EXACT POSITION, RELATIONS, AND STRUCTURE. an'', SECOND ANTENNAE; e', EXOPOD OF FIRST MAXILLE; e'', ENDOPOD OF SECOND MAXILLE; m., MOUTH; mx', FIRST MAXILLE; mx'', SECOND MAXILLE.

mid line parallel with the first (*Caligus curtus*). The lower lip is stretched over this framework from side to side and projects somewhat in front of the small anterior rods. It is divided at the center, and the edges thus formed are fringed with a tuft of hairs fully twice the length of those which fringe the rest of the mouth opening (fig. 6). In *Alebiou* there is a slit at either side instead of a single slit at the center, and the fringe is not much lengthened.

In the membrane of the lower lip, between the marginal rods just described, lies a complicated jointed framework of short rods which help support the membrane. Their number, arrangement, and shape

varies greatly in the different species as well as in the genera. In *Caligus curtus* there is a long rod on either side of the mid line, the two being approximately parallel to the very tips where they bend in suddenly together and are united for a short distance along the mid line (m, fig. 8). Connected with this united portion are three short transverse rods (t). All of these rods are narrow and cylindrical in shape (Pickering and Dana, 1838).

In *Caligus rapax* there is a large V-shaped rod at the base of the lips (v'), and another (v'') at the tip, the bases of the two Vs being toward each other and their sides being connected by a series of short, almost spherical rods (s, fig. 9). The V-shaped pieces are strongly flattened

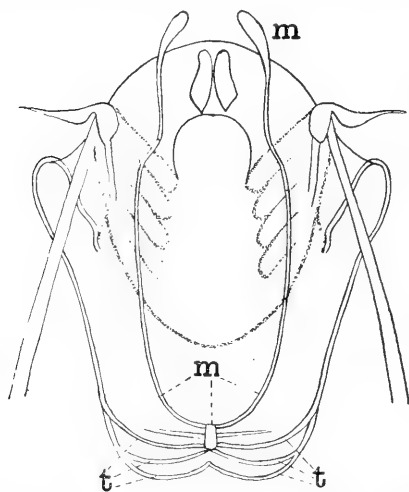


FIG. 8.—VENTRAL SURFACE OF THE MOUTH TUBE OF AN ADULT *CALIGUS CURTUS*. (AFTER PICKERING AND DANA.) m, LONGITUDINAL CENTRAL RODS IN FRAMEWORK OF LOWER LIP; t, TRANSVERSE RODS.

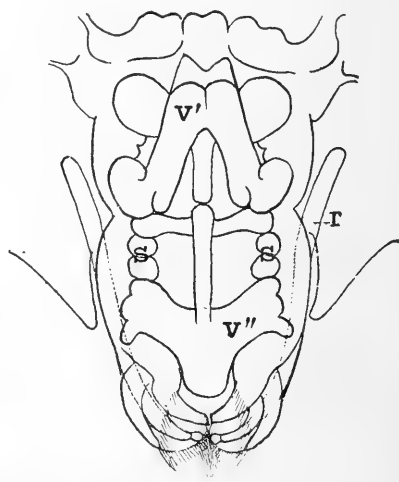


FIG. 9.—VENTRAL VIEW OF THE MOUTH TUBE OF *CALIGUS RAPAX* IN A LATE CHALIMUS STAGE. r, ROD ON LATERAL MARGIN OF LOWER LIP; s, v', v'', SHORT RODS FORMING THE FRAMEWORK OF THE LOWER LIP.

and much wider than thick, and might well be called laminae instead of rods.

The membrane forming the upper or dorsal portion of the mouth tube may be called the upper lip. Like the lower lip, it has a chitin rod (r', fig. 10) along either lateral margin, but in this instance, instead of being connected at the tip by short transverse rods, the chitinous edge is continuous around the anterior margin (fig. 6).

The proximal ends of the rods are enlarged and flexed, but not as sharply as those of the lower lip, and to them are attached muscles for moving the lip. There is no central framework in this dorsal membrane, but the latter is stretched from one marginal rod to the other. In *Caligus curtus* and *Lepeophtheirus edwardsi* the anterior portion of the chitinous margin is bent back in the form of a semicircle, into which fits a more or less circular flap (f) of soft membrane whose front

edge is crenated and fringed with long cilia (fig. 6, a). This flap is flexible and capable of more motion than the remainder of the lip, but to call the latter "immovable" (Pickering and Dana) is certainly misleading. The whole mouth tube moves together and freely, and certainly the dorsal portion of it is as movable as the ventral. In *Caligus rapax* the anterior portion of the chitinous margin, instead of being concave, is convex like the lower lip, and projecting in front of it is a narrow flexible membrane flap, with its front edge incised at the center and fringed throughout with cilia (fig. 10).

The statement of Pickering and Dana that the mouth "appears to be composed of the upper and lower lips, united with the different parts of a pair of maxillæ" (1838, p. 73) can not stand. Those authors made no attempt at any explanation of the position or connection of the maxillæ referred to, except to state that they corresponded to the first pair of maxillæ in decapod crustacea. And even this was not stated directly, but in a roundabout fashion, for they found a single pair of appendages which they said corresponded to the second maxillæ in decapod crustacea, but which they called the first maxillipeds. They proved to be in reality the second antennæ; it must have been, therefore, the first maxillæ which they thought were combined with the upper and lower lips. But we have already seen that both pairs of maxillæ are fully accounted for outside the buccal tube. And A. Scott has shown by the innervation in *Lepeophtheirus pectoralis* that the claws which Pickering and Dana considered as appendages of their "first maxillipeds" are really the first maxillæ.

Of the two pairs of maxillipeds, the first are situated about halfway between the apex of the mouth and the lateral margin of the carapace. Each one of this pair is two-jointed, the basal joint moderately stout while the longer terminal joint is very slender and terminates in two or three short and stout spines. Their function is probably that of keeping the mouth clean of foreign matter by a sort of combing motion (fig. 11).

The second maxillipeds arise near the mid line, a little posterior to

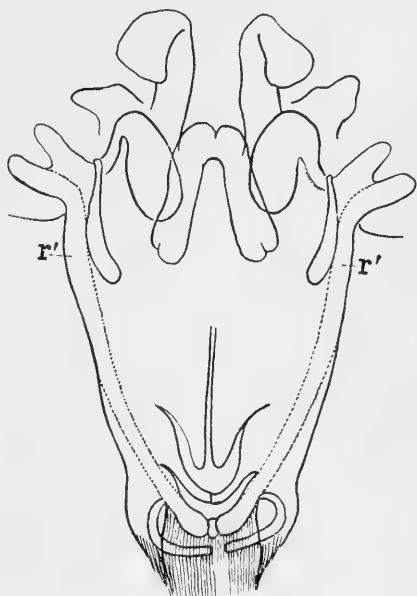


FIG. 10.—DORSAL SURFACE OF THE MOUTH TUBE OF *CALIGUS RAPAX* IN AN ADVANCED CHALIMUS STAGE. *r'*, ROD ON LATERAL MARGIN OF FRAME-WORK OF UPPER LIP.

the first. Each is made up of two joints, the basal of which is much swollen and liberally supplied with stout muscles, while the apical one is a powerful claw curved over inward and carrying a spine on its inner margin (fig. 12).



FIG. 11.—FIRST MAXILLIPED OF *LEPEOPHTHEIRUS EDWARDSI*.

These are the chief organs of prehension, as already noted, and are usually much larger in the male. Their relative size, however, varies greatly in the different species and genera; in one they are evidently the chief reliance for clinging to the host or to the female; in another the second antennæ are so much enlarged and the first maxillæ in the male are so stout that these maxillipeds evidently share the honors at the least.

Lepeophtheirus innominatus is a good example of the former, the basal joints of the second maxillipeds being so large as to fill the central portion of the carapace (Plate XXVIII).

And *Caligus schistonyx* is a good example of the latter, the terminal claw of the second maxillipeds being small and very weak while the second antennæ are large and stout (Plate VI).

In many other species the two are just about equal in strength and efficiency.

Between the swollen basal joints of the second maxillipeds arises the furca or sternal fork, which consists of a stout chitin plate whose tip is bifid, much like an old-fashioned bootjack.

It varies considerably in form and relative size in the different species, and for some authors it serves on this account as a secondary basis of classification. It is frequently of considerable service in this direction, and in one or two cases

is sufficiently different to serve as the distinguishing characteristic of the species. Witness the double bifurcation in *Lepeophtheirus hippoglossi* and *L. bifurcatus*, and the peculiar form in the genus *Gloioptotes* and in *Caligus platytarsi*, and the entire absence of this appendage in the genus *Aleobion* (see Plates XX, XXIII). Several uses have been suggested for the appendage. I. C. Thompson thinks that it

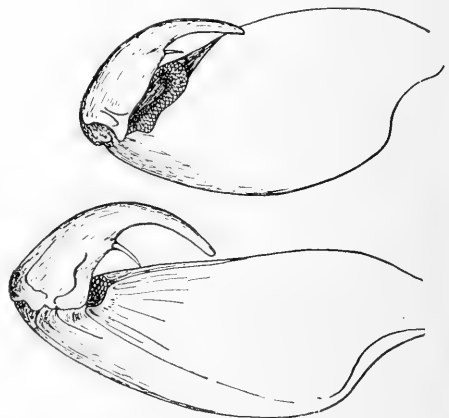


FIG. 12.—THE SECOND MAXILLIPEDS OF THE ADULT *CALIGUS BONITO*. UPPER FIGURE, THE MALE, WITH A LARGE BONY PLATE ON THE BASAL JOINT; LOWER FIGURE, THE FEMALE.

may act as a support or crutch on which to raise the body of the parasite high enough from its host to render the use of the swimming feet and mouth organs possible. But there are several considerations which render such a function quite improbable. In the first place the parasite uses its feet when on its host simply to keep the water beneath the carapace agitated for purposes of respiration; and there is space enough for this, ordinarily, without raising the carapace at all. Again, the raising of the carapace and balancing it upon this fork would weaken the parasite's hold enough to render any sudden or unlooked for friction dangerous. And then, if the fork were to function as a support there would certainly be need of some muscular arrangement to adjust, hold, and remove it, as occasion demanded; but there are no such muscles in connection with this fork, and, so far as can be determined, no means of adjustment whatever.

And, finally, there would be very little demand for such a support, because when the terminal claws of the second maxillipeds are driven into the skin of the host the parasite's body is ordinarily raised to a greater distance than the length of the sternal fork, and by straightening the basal joints of the same appendages it can be raised still farther without in the least loosening its hold.

A. Scott, in the memoir already referred to, writes that the function of the furca is unknown. But it seems at least possible that it may be used for the purpose already suggested, to prevent any slipping backward upon the host when the parasite has loosened its claws and is moving about over the host's body.

It would thus correspond in function as well as position with the papillated area and the spines upon the basal joints of the second maxillipeds in the Argulidæ. Its position between the bases of the second maxillipeds, its backward inclination, and the entire absence of spines or papillated areas upon the maxillipeds themselves give at least a probability to this view.

Of the swimming legs the first and fourth pairs are uniramous in nearly all the genera while the remaining pairs are biramous. The genus *Alebion* has the legs all biramous, but the fourth pair are rudimentary. As will be seen from the key there are several other genera not represented in North American waters which have all four pairs biramous like *Alebion*, while *Calistes* and *Luethkenia* have the first pair only uniramous, the other three being biramous.

In the first pair the basipod is simple and considerably larger than the terminal joints, except in *Caligodes*, where it is the same size. It frequently carries upon its posterior ventral surface one or two spines whose bases are enlarged and which are inclined backward (fig. 13). The exopod is well developed, two-jointed and in line with the basipod. The terminal joint is often appropriately called the "hand" on account of its shape.

It carries on its outer margin three claws of about the same length, at the outer posterior corner a long plumose seta or a spine longer than the claws, and on its posterior border three stout plumose setae. Occasionally one of the terminal claws is developed at the expense of the others, as in *Lepeophtheirus monacanthus* and *L. quadratus* and *Caligodes megalcephalus*.

In the genus *Gloiopotes* two of the claws are curiously modified into a three-pronged fork.

One or two species have been reported in which there were no plumose setae upon the posterior border (*Caligus haemulonis* and *C. productus*).

The endopod of these first legs is rudimentary and is represented in some species by a minute joint bearing setae (*Lepeophtheirus pectoralis*) and in others simply by the setae (*Caligus rapax* and *C. bonito*).

In the second pair of legs both exopod and endopod are well developed, two- or three-jointed, and plentifully supplied with plumose setae.

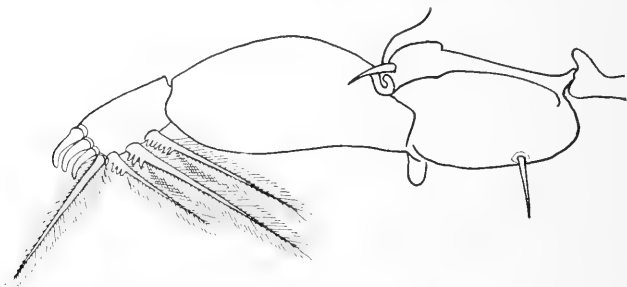


FIG. 13.—FIRST SWIMMING LEG OF ADULT FEMALE CALIGUS BONITO, VENTRAL VIEW.

These latter point inward on either leg and are often long enough to overlap on the mid line, thus forming a very effective swimming lamina. These legs are almost exactly alike in all the genera. The large basipod carries on its posterior margin a stout plumose seta, inclined backward and inward at an angle of about 45° . The basal joint of the exopod is longer than either of the other two joints and carries a plumose seta on its inner margin and a stout spine at the outer distal corner (fig. 14). The second joint is short, with a plumose seta on the inner margin and a spine at the outer distal corner. The terminal joint is almost circular in outline and carries a row of six plumose setae around its edge and a spine at the outer corner.

This exopod is in nearly the same line as the basipod, but the endopod is bent inward until in *Caligus* and *Lepeophtheirus* it is at right angles to the basipod, while in *Gloiopotes* and *Alebion* it is nearly parallel with it, but running in the opposite direction. The basal joint of this endopod is short and carries a single plumose seta on its inner margin. The second joint is the longest of the three and usually the widest, and carries two plumose setae at its distal end. The circular

terminal joint is set into the outer distal corner of the second joint, which is much narrowed at the end for this purpose, and it carries a row of six plumose setæ around its margin. The endopod is never armed with spines, like the exopod, in any species.

In the third pair of legs the basipods are widened out into a broad lamina, those from either leg meeting and fusing at the mid line into a single solid apron the entire width of the thoracic area, and often nearly equaling the width of the carapace (fig. 15). This forms a powerful swimming organ and at the same time assists greatly in prehension by closing the posterior edge of the carapace and enabling it to act as a large sucking disk. In addition to these two functions, the lamina is also inclined backward, and being stiff it must make a powerful prop to assist in the prevention of slipping backward. The exopods and endopods of this pair of legs are very small and are attached to

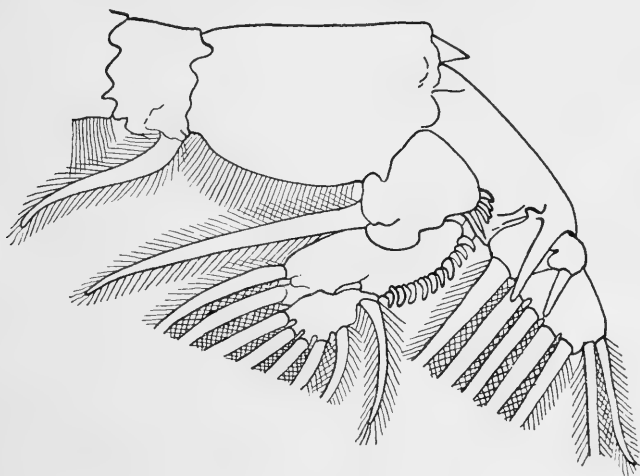


FIG. 14.—SECOND SWIMMING LEG OF ADULT FEMALE *CALIGUS BONITO*, VENTRAL SURFACE.

the outer margin of the basipod laminae, usually some little distance apart. In some species, however, they are so close together as to be almost fused. The endopod is one or two jointed, the basal joint being very short and almost hidden by the edge of the lamina, while the terminal joint is circular. The exopod is two or three jointed, the basal joint armed with a stout claw on its ventral surface, the two terminal joints being the halves of a small ellipse. In some species the two terminal joints are elongated and appressed close to the margin of the basal lamina. Both rami are plentifully supplied with plumose setæ and fringed with fine hairs.

These first three pairs of legs are connected across the mid line by sternal plates which increase in width from in front backward. Those of the second and third pairs are fringed with hairs along their posterior margins, while in the first legs this margin is smooth.

The fourth pair of legs are very different from the others, and they vary greatly in the different species and genera, thus furnishing often a useful means of identification (see Plates). In *Caligus*, *Lepeophtheirus*, and allied genera they consist of a basipod usually as long as all the remaining joints put together, and a one, two, or three jointed exopod with no trace of an endopod.

The exopod is really always three-jointed, but in development the joints often become so thoroughly fused that all trace of the original division is lost. Each exopod joint bears at its outer distal corner a sharp spine, usually straight, and the terminal joint ends in three spines of unequal length, the inner one being the longest. In several species there are short semicircular fringed laminae at the bases of

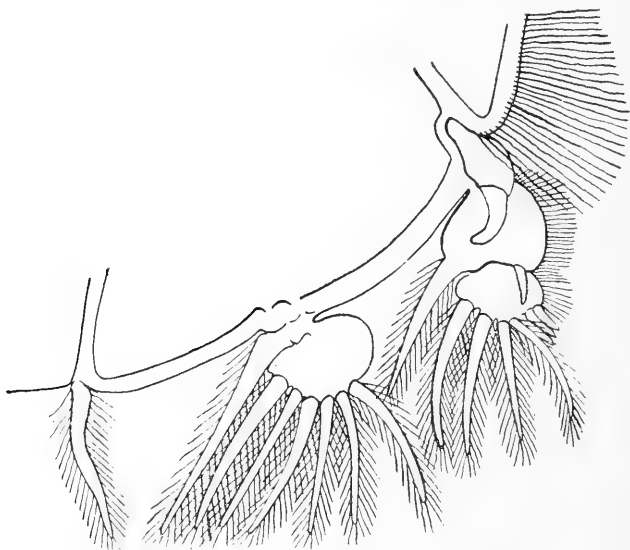


FIG. 15.—THIRD SWIMMING LEG OF ADULT FEMALE *CALIGUS BONITO*, VENTRAL VIEW.

these spines on the ventral surface (*Caligus rapax*, *teres*, *mutabilis*, etc.). In *Gloiopotes* there is a continuous fringe of short, stiff spines along each joint, on its outer margin,

The size and length of these legs is even more variable, and we can find all gradations from the mere rudimentary stumps in the genera *Altbion* and *Pseudocaligus* up to legs which reach far beyond the tips of the anal laminae (*Caligus longipes*, *Lepeophtheirus longipes*, *Caligus nanus*, etc.). In a few species the spines on these legs are widened and flattened into laminae covered with hairs (*Caligus hirsutus*, *C. platytarsi*).

The fifth legs are rudimentary and are attached to the posterior end of the genital segment. They consist of a short lamellar basipod, terminated by two or three short spines or setae (5, fig. 1). These fifth legs are usually more prominent in the male than in the female, where they are often reduced so much as to be practically lost.

SUMMARY.

1. The body of the Caligids here discussed is made up of three parts or regions—a cephalo-thorax covered with a carapace, a free thorax of two segments the posterior of which is the genital segment, and an abdomen of from one to four segments.

2. The cephalon bears seven pairs of appendages, namely: Two pairs of antennæ, one pair of mandibles, two pairs of maxillæ, and two pairs of maxillipeds. Each of the five thorax segments carries a single pair of swimming legs, those on the fifth segment being rudimentary in all the genera, while the fourth pair are also rudimentary in *Alcbion* and *Pseudocaligus*. The abdomen has no appendages, but carries at its posterior end the paired anal laminae.

3. The carapace is oval or elliptical. Articulated with its anterior margin are the frontal plates or modified basal joints of the first antennæ. In six of the genera—*Caligus*, *Pseudocaligus*, *Caligodes*, *Synestius*, *Homoiotes*, and *Parapetalus*—these frontal plates are provided with lunules or sucking disks. The carapace is divided by grooves or sutures into four areas—the cephalic, the thoracic, and the right and left lateral areas—the principal grooves being arranged in the shape of the letter H. The posterior part of the body is usually much narrower than the carapace.

4. The first antennæ are very fully innervated, and thus become highly sensitive. The second antennæ carry hooks or claws on their terminal joints, and are modified into stout prehensile organs, particularly large and strong in the male. The first maxillipeds are weak and apparently useless, unless it be to keep the mouth parts clean. The second maxillipeds are large and well developed, and, with their terminal claws, form the chief organs of prehension for holding the parasite on its host.

5. The eyes are simple and paired, but are fused together on the median line instead of being separate, as in the Argulidæ. The mouth parts are modified into a proboscis for sucking up the food; the single pair of mandibles are concealed within this proboscis, while the two pairs of maxillæ are outside and free from it. The first pair are simple, but rudimentary, and have migrated to a position near the margin of the carapace behind the second antennæ. The second maxillæ are simple in those genera which have lunules on the frontal plates, but are bifurcate in the remaining genera. They are situated close to the proboscis on either side.

6. Situated upon the ventral surface, on the mid line, between the bases of the second maxillipeds and the first swimming legs, is the furca or sternal fork, consisting of a stout chitin plate whose tip is bifid much like an old-fashioned bootjack. It points backward, and its use is probably to prevent the animal from slipping while on its host.

B. INTERNAL MORPHOLOGY.

Body wall.—The body wall is made up of three layers (1), the outside layer of chitin cells forming the exoskeleton or cuticle (c. fig. 16); (2), the cellular "hypodermis" (h); (3), the connective tissue lumina which lines the entire body wall and supports the alimentary canal and

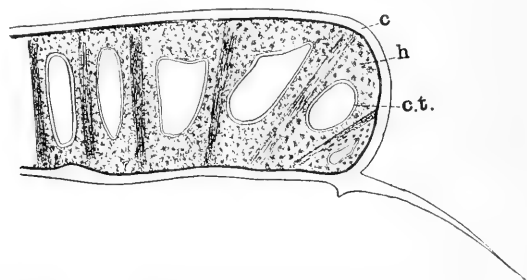


FIG. 16.—SECTION OF BODY WALL OF *LEPEOPHTHEIRUS PECTORALIS*. (AFTER CLAUS.) C, CUTICLE OR CHITIN EXOSKELETON; c.t., CONNECTIVE TISSUE ENDODERM; h, CELLULAR HYPODERMIS.

other organs (c. t.). There is no continuous body cavity, but only a series of lacunæ, through which the colorless blood is driven in spasmodic currents. Furthermore these lacunæ are so situated that no extensive circulation is anywhere possible, but there is instead a series of limited circuits which interlace with one another.

ALIMENTARY CANAL.

The mouth opens directly into a short, curved œsophagus, which passes backward between the supra and infraœsophageal ganglion, along the dorsal surface of the latter, and enters the ventral surface of the stomach a little behind its anterior end. It is very narrow throughout its entire length and is easily overlooked in both longitudinal and transverse sections (oe. fig. 17). The stomach is many times the width of the œsophagus, but is only a little wider than the intestine. It is situated close to the ventral surface of the carapace and stretches from just behind the eyes backward along the mid line at least to the center of the thoracic area (st.).

It is somewhat wider in front than posteriorly, and is also raised away from the ventral surface above the posterior end of the infraœsophageal ganglion. This raised end is produced into a median lobe or cæcum, reaching forward over the œsophagus and between the ovaries or testes. The stomach tapers uniformly toward the posterior end, where it opens directly into the intestine (i). There is a constriction at this point like the beginning of a sphincter muscle, but the opening can not be closed. The intestine, therefore, is a direct continuation of the stomach; it enlarges considerably just back of the stomach, then contracts in the fourth thoracic segment, enlarges again in the

genital segment, contracts as it enters the abdomen, enlarges in the abdomen, and contracts finally to form a short rectum in front of the anus. The latter is terminal and situated between the anal laminae (fig. 18).

At the anterior end where it leaves the stomach the intestine is on the ventral sur-

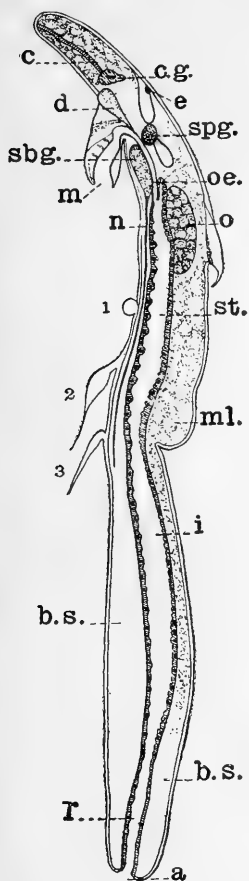


FIG. 17.—LONGITUDINAL SECTION OF *LEPEOPHTHEIRUS* SHOWING RELATION OF INTERNAL ORGANS. (AFTER A. SCOTT.) a, ANUS; b. s., BLOOD SPACE; c, FILAMENT DUCT; c. g., FILAMENT GLAND; d, DUCT OF DIGESTIVE GLAND; e, EYE; i, INTESTINE; m, MOUTH; ml., MUSCLE; n, VENTRAL NERVE; o, OVARY; oe., OESOPHAGUS; r, RECTUM; sbg., SUBESOPHAGEAL GANGLION; spg., SUPRAESOPHAGEAL GANGLION; st., STOMACH.

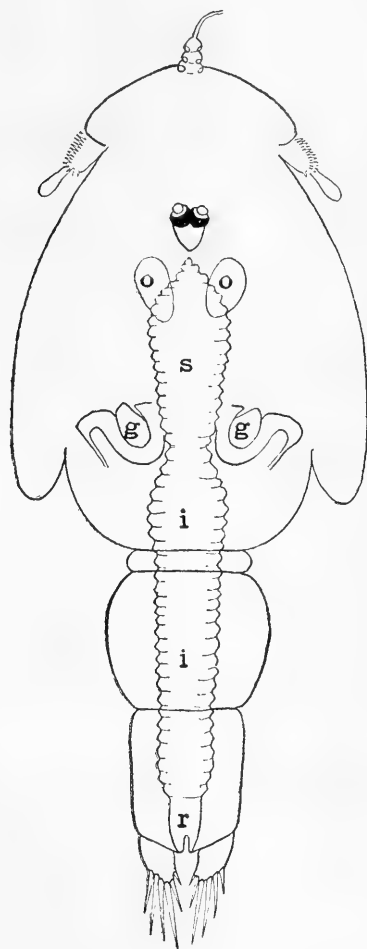


FIG. 18.—THE DIGESTIVE SYSTEM OF *CALIGUS RAPAX*; CHALIMUS FULLY GROWN. g g, DIGESTIVE GLANDS; i, INTESTINE; o, OVARY; r, RECTUM; s, STOMACH.

face and it remains there till it passes into the genital segment. Here it lies close to the dorsal surface and remains there until after it enters the abdomen, where it turns downward and occupies the center of the body.

In transverse sections of young males and females the stomach and

intestine appear circular in outline. But as development progresses and the reproductive organs mature, they gradually encroach upon the digestive tube and compress it. The ovaries or testes being located above the anterior part of the stomach, push the latter together side-wise and also push it downward, the result being that it assumes the

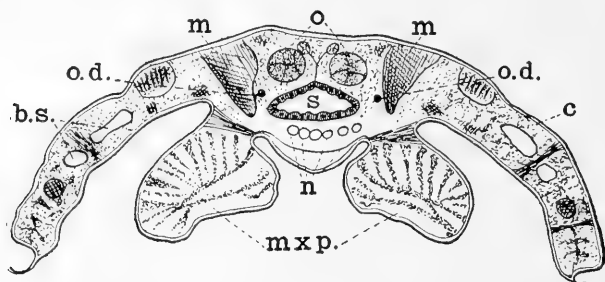


FIG. 19.—TRANSVERSE SECTION OF *LEPEOPHTHEIRUS* IN THE REGION OF THE SECOND MAXILLIPEDS. (AFTER A. SCOTT.) b. s., BLOOD SPACES; c, CHITIN EXOSKELETON; m, MUSCLE; mxp., MAXILLIPEDS; n, VENTRAL NERVES; o, OVARY; o. d., OVIDUCT; s, STOMACH.

form of a triangular prism, with one of the angles toward the dorsal surface (fig. 19).

In the genital segment, on the contrary, the convolutions of the oviduct are below and outside of the intestine, and consequently push it together sidewise and upward. The result is again a triangular prism, but this time one of the angles points downward and a flat side is in contact with the dorsal surface (fig. 20). By the time the sexual organs are fully mature there has been a strong compression of the digestive organs.

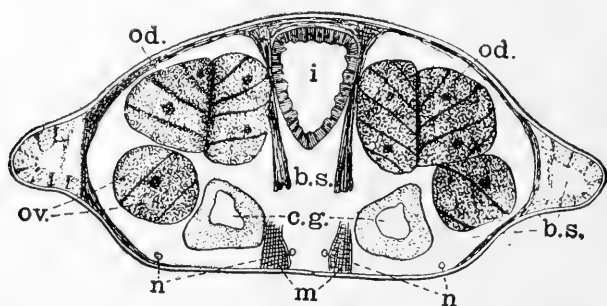


FIG. 20.—CROSS SECTION OF THE GENITAL SEGMENT OF A *LEPEOPHTHEIRUS*. (AFTER A. SCOTT.) b. s., BLOOD SPACE; c. g., CEMENT GLAND; i, INTESTINE; m, MUSCLES; n, NERVES; od., OVIDUCT; ov., OVA.

The wall of the digestive canal is not smooth, but is constricted transversely at fairly regular intervals. When examined in the living animal this wall is seldom at rest, but shows a series of peristaltic movements passing intermittently along from the stomach to the intestine, or vice versa. The action usually continues in the same

direction for some time and is then reversed. Under its influence the contents of the stomach and intestine are thoroughly mixed and brought in contact with every portion of the digestive surface. As there is no valve between the stomach and intestine, the contents of the two can pass back and forth without hindrance.

The alimentary canal is lined with endoderm, which is continuous with the ectoderm at the mouth and anus. While the general structure of this endoderm is distinct from that of the ectoderm, there does not seem to be very much differentiation in the different body regions. It is almost exactly alike in structure throughout its entire length. But in both the stomach and intestine it is thrown up into longitudinal folds which increase the digestive surface.

In both *Caligus* and *Lepeophtheirus* these folds increase in size as they pass backward from the anterior end of the stomach and attain their maximum in the genital segment, after which they decrease toward the rectum. Connected with these folds and usually most abundant alongside their crests are numerous gland cells, which, doubtless, secrete a digestive juice, since they stain differently from the remainder of the endoderm.

Connected with this alimentary canal are two pairs of digestive glands, which probably function something like the salivary glands and the liver in higher animals. The first pair is situated in the anterior part of the carapace and is made up of three portions. The smallest of these is median, and situated just in front of the mouth tube. The other two portions are larger, and are located sometimes close to the lateral margin of the carapace, just behind the first antennæ (*Lepeophtheirus pectoralis*, *g'*, fig. 21), sometimes much nearer the median line (*Caligus bonito*). A duct (*d*) extends from the anterior portion of each lateral division across to the side of the median division, and the latter gives off at its posterior end, just below the œsophagus, a third duct, which passes backward and enters the anterior end of the stomach.

The second pair of digestive glands (*g''*) is situated at about the center of the thoracic area, on either side of and close to the median line, and about opposite the posterior end of the stomach.

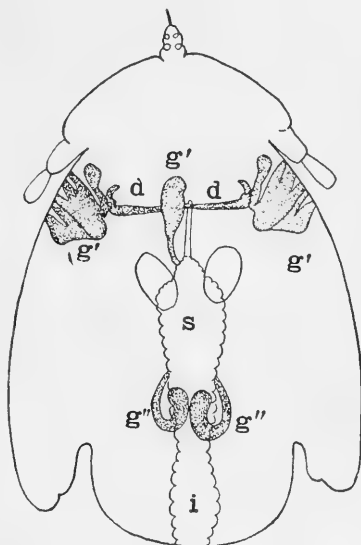


FIG. 21.—DIGESTIVE GLANDS IN *LEPEOPHTHEIRUS*. (AFTER A. SCOTT.) *d*, DUCTS; *g'*, ANTERIOR GLANDS; *g''*, POSTERIOR GLANDS; *i*, INTESTINE; *s*, STOMACH.

Both pairs of glands are dark brown in color, but while the first pair are partially or wholly concealed among the muscles and appendages of that portion of the carapace, the second pair stand out conspicuously in dorsal view, since they are close to the dorsal surface. In some species they are quite small and shaped like a comma, the large, rounded body lying upon the upper surface of the intestine, while the curved tail bends around laterally to the ventral surface of the intestine, where it gives off a duct leading to the posterior end of the stomach.

This is the condition in *Lepeophtheirus pectoralis*, while in *Caligus rapax* the gland is much larger, horseshoe-shaped, and entirely free from the intestine, though lying close to it. The duct here is given

off from the outer arm of the horseshoe, turns downward and then forward to enter the stomach (fig. 22).

In many of the other species and genera these glands are of a decidedly different shape if the brown bodies visible in the thoracic areas are any criterion. Thus by a reference to the plates of the new species here published it will be seen that in *Lepeophtheirus edwardsi*, *L. longipes*, *L. chilensis*, and *L. parviventris* as well as in *Caligus pelamydis* these brown spots show as quite regular oval or elliptical bodies flattened on the inner sides. In *Gloiopotes ornatus* they are very

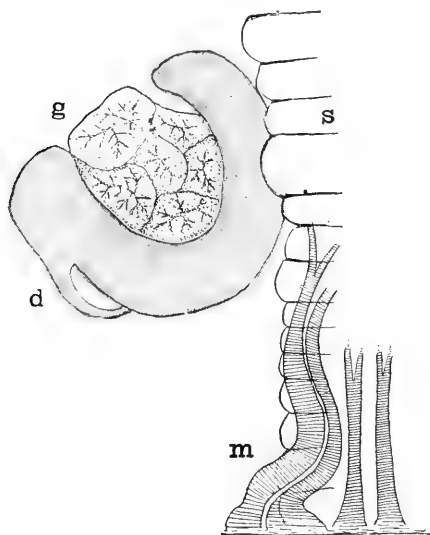


FIG. 22.—POSTERIOR DIGESTIVE GLANDS OF CALIGUS RAPAX. d, DUCT; g, GLAND; m, MUSCLES; s, STOMACH.

regular ellipses without being flattened at all. In *Caligus bonito* they are very small and seem fused on the mid line into a bean-shaped body. In three species of *Caligus*—*latifrons*, *exilis*, and *aliuncus*—they are comma-shaped with the small end pointing forward, and in the last species also outward. In *Caligus mutabilis* they are even unlike in the two sexes, having a club-shape in the male, the two clubs being strongly curved with their small ends toward the front and their concave sides toward each other. In the female they have the shape of a spherical triangle, the apices pointed backward, with a small spherical enlargement on the outer side at about the center.

In *Lepeophtheirus hippoglossi* they have the form of paragraph marks placed back to back. In the male of *Caligus schistonyx* they show up as hatchet-shaped bodies, widely separated, and the handles

pointing diagonally outward. And finally in *Caligus teres* and *Lepeophtheirus dissimulatus* they appear to be made up of two parts, differing considerably in size, the smaller part being anterior in the *Caligus* and posterior in the *Lepeophtheirus* species. A section of one of these glands shows it to be divided into small lobules much like a pancreas, and in the center of each lobule can be seen the divisions of the duct for collecting the secretion.

THE BLOOD AND CIRCULATION.

The blood is made up of a colorless fluid in which floats numerous corpuscles also colorless. These corpuscles are of different sizes and shapes and are even capable of being changed in shape to accommodate the diameter of the spaces through which they pass. There is no heart nor blood vessels of any sort. The circulation is entirely lacunar, and consists of an irregular pulsation or streaming of the blood back and forth through the spaces left around the internal organs and muscles, and between the bands of connective tissue in the body wall. The propelling agent of these blood streams seems to be the peristaltic movements of the alimentary canal and the respiratory movements of the rectum. And since the peristaltic movements pass from the anterior to the posterior for a portion of the time and then are reversed, so in like manner the blood streams continue to flow in one direction for a short time and then slacken and reverse. And, again, since the movements of neither the intestine nor the rectum are uniform or continuous, so those of the blood current are spasmodic and irregular. Often also, particularly at the times of slackening prior to reversal, the motion consists of a simple oscillation back and forth, without any definite movement in either direction.

The course of the blood streams varies so much in the different species that it would be necessary to describe each separately. The only descriptions given are for *Caligus curtus* by Pickering and Dana (1838), and for *Lepeophtheirus pectoralis* by A. Scott (1901), and these vary in many essential particulars.

The following general statements will apply to all the species so far observed. There is a central current along the median line under the alimentary canal. A pair of lateral currents start from the region just behind the eyes, and each flows outward and backward to the tip of the lateral lobe on its side. It then turns forward along the lateral margin of the carapace till it reaches the muscles connected with the mandibles where it turns toward the median line.

A second pair of lateral currents start from nearly the same region, course backward through the thoracic area and the free segment into the genital segment. Here they turn outward, following the reproductive organs to the posterior end of the segment, where they turn

around inward and meet on the median line beneath the intestine. The general course of these main currents is the same, but the details differ greatly. As Pickering and Dana well say, they "are merely main directions, and the blood flows into them or from them through all their extent." The points where the main currents break up into smaller currents and the courses of the latter also vary greatly. Pickering and Dana describe in *Caligus curtus* two points upon the median line where there is a valvular action, functioning somewhat as a heart in this circulation.

One of these is situated at the apex of the posterior thoracic joint; there are here three valves, one in the center ventrally and one on either side dorsally, the dorsal and ventral valves opening alternately. The pulsations are regular, and from 30 to 40 a minute. The second point is between the basal joints of the second antennæ. (Pickering and Dana call them the first maxillipeds.) Here there is a single membranous valve playing back and forth and thus preventing the return of the blood that has passed it in either direction.

It must not be inferred that these two descriptions are characteristic of the two genera and that *Caligus* species have the valves while *Lepeophtheirus* species do not. This would not be true; the descriptions merely serve to indicate the amount of diversity to be found in the details of circulation.

After examining a larger number of species while alive it may be found advantageous to publish these details in a future paper.

RESPIRATION.

There are no independent organs of respiration, but Hartog, in 1880, described the anal respiration in *Cyclops*, *Canthocamptus*, and allied genera, and suggested that the blood of these parasites may be aerated in the same way. That this is the actual condition the present author has proved in several instances. And first, as noted by A. Scott (1901, p. 21), the chitin exoskeleton is so thick over nearly all the body that very little aeration could be effected through it, while the endoderm lining the rectum is thin enough for this purpose.

Then there are the necessary muscles for such respiration, dilators running from the abdomen wall to the rectum, while the peristaltic movements, common to the rectum as to the rest of the alimentary canal, serve for the contraction. These dilator muscles are figured by Claus (1864) for *Lepeophtheirus thompsoni* (which he calls *Caligus branchialis*) in Plate XXXIII, fig. 5 of his memoir. They are said to be present in *Lepeophtheirus pectoralis* by A. Scott (1901, p. 21), and they have been observed by the present author in *Lepeophtheirus edwardsi* and in *Caligus rapax* (fig. 23) and *C. bonito*. These facts create a strong presumption in favor of the existence of such respiration, and it was only left to actually observe it in the living animal.

Such observation has been made in the three species last named and the respiration was seen to be exactly like that described by Hartog for *Cyclops*, save that it was not as regular.

It can be seen to best advantage in late chalimus stages, in which the walls of the abdomen are usually very transparent, while the movement itself seems more vigorous.

When the rectum contracts during peristaltic movements there is left only a linear cavity along the mid line. Then the dilator muscles immediately pull the rectum out to its full width, at the same time opening the anal valves for an instant. This action fills the rectum with outside water, which then operates by endosmosis through the thin rectum wall.

This same method of respiration is as normal to the nauplii of these parasitic forms as it is to those of the free-swimming genera, and the author has repeatedly observed it also in the metanauplius of *Caligus rapax* and in the chalimus of the same species, as well as those of *Caligus curtus* and *Lepeophtheirus edwardsi*. The fact that it

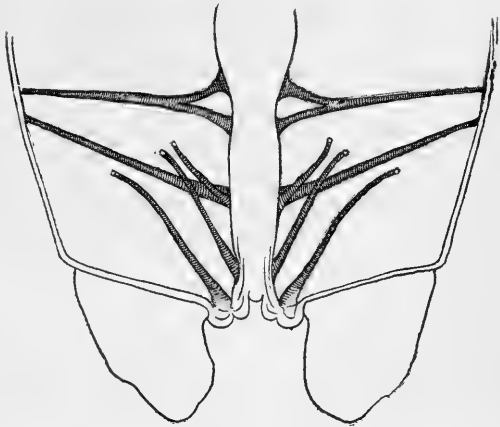


FIG. 23.—OBLIQUE MUSCLES WHICH OPERATE THE RECTUM IN *CALIGUS RAPAX* DURING RESPIRATION.

is thus the only method of respiration throughout the period when the legs are as yet undeveloped, and that all the muscles concerned in it remain in the mature form, furnishes strong circumstantial evidence that it is the method also in the other forms here described, but in which it has not as yet been actually observed.

MUSCULAR SYSTEM.

Copepods belonging to the genera here considered are as a general rule so transparent that their musculature can be determined with very little effort. And then the muscles are so plainly striated that there is very little danger of mistaking them for any other tissue. Indeed, the striation in the muscles of *Caligus curtus* were among the very first observed in any animal, and their discovery here by Pickering and Dana was about contemporaneous with that in human muscle by Doctor Hodgkin. (Pickering and Dana, 1838, p. 81, footnote.)

The frontal plates are flexed by two short and slender muscles, situated in nearly the same place in all the genera, directly behind the lunules, attached to the posterior portion of the plates, and running

backward and inward. They bend the frontal plates downward, and thus assist in attaching the lunules (a, figs. 24 and 25).

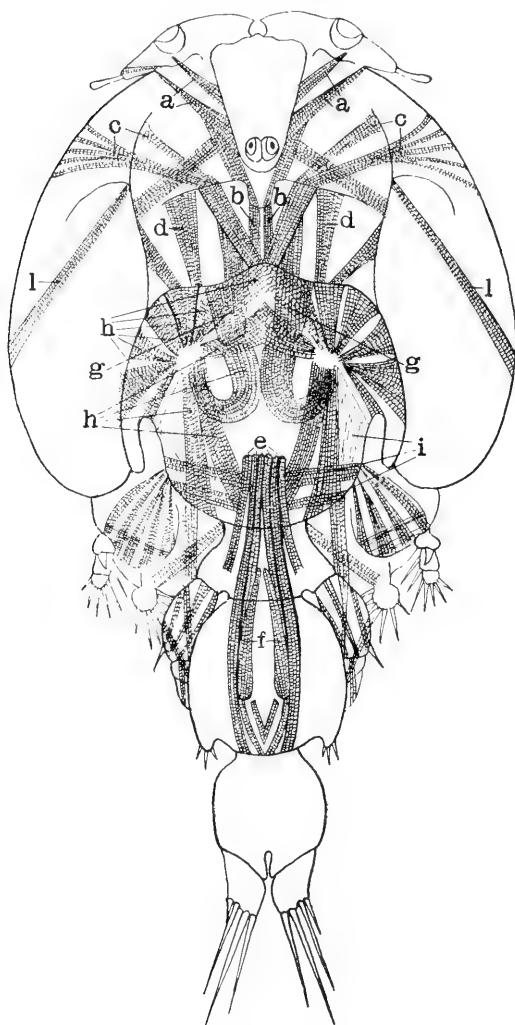


FIG. 24.—MUSCULATURE OF A MALE CALIGUS CURTUS. (AFTER PICKERING AND DANA.) a, FLEXORS OF FRONTAL PLATES; b, c, d, MUSCLES PRODUCING FLEXION BETWEEN THE CEPHALON AND THORAX; e, EXTENSORS OF FREE SEGMENT, GENITAL SEGMENT AND ABDOMEN; f, EXTENSORS BETWEEN THE GENITAL SEGMENT AND ABDOMEN; g, PRODUCE FLEXION BETWEEN THORACIC AND LATERAL AREAS; h, i, MOTOR MUSCLES OF THE SECOND AND THIRD LEGS; l, MANDIBLE MOTORS.

side of these are the longest and extend through the genital segment and into the abdomen.

The third or inner pair terminate in the genital segment.

In connection with these we find shorter muscles farther back arising near the center of the genital segment and terminating in the

There are three pairs of muscles which operate in producing flexion between the cephalon and the thorax along the cross-bar of the H-shaped groove already described. The shortest of these three pairs are the nearest to the median line and nearly parallel with it (b). The second pair are very much larger and extend from the middle of the cross-bar frontward and outward, at an angle of 45 degrees, to the very edge of the carapace (c).

The third pair are again nearly parallel with the mid line but much farther away from it than the first pair (d).

The muscles for the extension of the free (fourth) thorax segment, the genital segment, and the abdomen arise side by side in pairs near the median line in the posterior portion of the thoracic area (e). The outer pair are the shortest and terminate near the center of the fourth segment, controlling the movements of that segment. The pair next in-

abdomen (f). These of course produce flexion between the two segments in which they are situated.

The combined action of all these muscles produces a lateral motion of the posterior segments of the body, flexion, extension, or a telescopic contraction of the different body regions. In addition to these muscles the thoracic area on either side of the mid line is provided with a

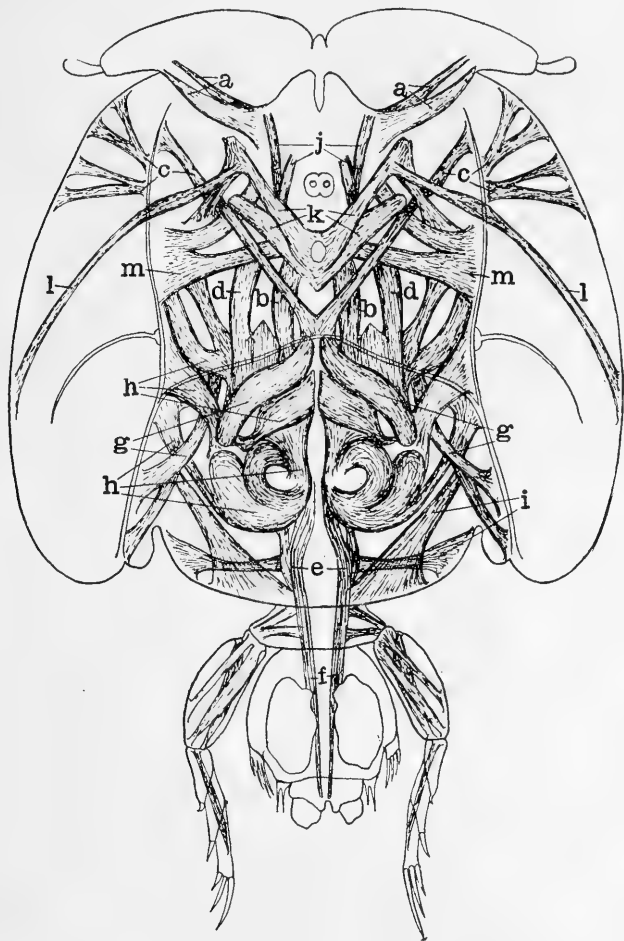


FIG. 25.—MUSCULATURE OF A MALE *HOMOIOTES PALLIATA*. a, FLEXORS OF FRONTAL PLATES; b, c, d, MUSCLES PRODUCING FLEXION BETWEEN THE CEPHALON AND THORAX; e, EXTENSORS OF FREE SEGMENT, GENITAL SEGMENT AND ABDOMEN; f, EXTENSORS BETWEEN THE GENITAL SEGMENT AND ABDOMEN; g, PRODUCE FLEXION BETWEEN THORACIC AND LATERAL AREAS; h, i, MOTOR MUSCLES OF THE SECOND AND THIRD LEGS; j, ELEVATORS OF THE MOUTH TUBE; k, MOTOR MUSCLES OF MOUTH TUBE; l, MANDIBLE MOTORS; m, MOTORS OF SECOND MAXILLE.

number of muscles, some extending forward, others backward, and still others laterally. A few of these are for producing flexion between the thoracic and lateral areas and assisting the three pairs already described in flexing the thorax on the cephalon (g). It is the combined action of these muscles which arches or depresses the carapace, and which makes of it an organ of prehension in the form of a large, suck-

ing disk. But by far the larger portion of these thorax muscles are the powerful locomotor agents which operate the second (h) and third (i) swimming legs and make of them the chief propelling organs.

Each of the appendages and the mouth tube are also plentifully supplied with muscles, both flexors and extensors, and a good idea of the service performed by each may be obtained from an examination of its muscle supply. The anterior antennæ have two extensors and one flexor. The powerful muscles used in the second antennæ for clasping are quite similar to those in the second maxillipeds (fig. 26) and nearly fill the basal joint.

They are much larger and stronger in the male than in the female. We have already seen that the appendages themselves are larger in the male and form the chief organs for clasping.

There are four short and narrow muscles attached to the base of the proboscis framework by means of which the latter may be elevated to a right angle with the ventral surface (j). Other muscles extend posteriorly and laterally and assist in the elevation or depression of the tube when sucking up food (k).

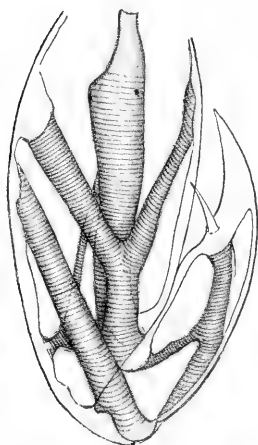


FIG. 26.—MUSCULATURE OF THE SECOND MAXILLIPEDS OF CALIGUS RAPAX.

The muscles controlling the mandibles are surprisingly large and strong and fairly prove that these appendages are vigorously used in the process of eating, which is hardly conceivable if the creature feeds on mucus. They extend outward and backward obliquely to the very margin of the carapace about opposite the first pair of legs (l).

In the female the muscles of the first maxillæ are as small and degenerate as the maxillæ themselves; but in the male they are much better developed and must give these append-

ages a strong clasping power. The muscles of the second maxillæ are better developed than those of the first, and they are larger and stronger in such genera (*Lepeophtheirus*, etc.) as have these appendages bifurcate (m).

The muscles of the first maxillipeds are very meager in both quantity and quality, and, with the weak structure of the appendages, show plainly that they are not of much service to the animal. And Pickering and Dana are probably right when they bestow upon them the appellation "rudimentary." A good idea of the musculature of the second maxillipeds can be obtained from fig. 26. These are the principal clasping organs, and the muscles which operate them are both large and stout, particularly the flexor of the terminal claw. The first three pairs of feet possess a complicated musculature, as is well shown in fig. 25, which makes them powerful propelling organs.

But the fourth pair, even in those species in which they are relatively large (*Lepeophtheirus longipes*, etc.), are notably defective in muscles. Hence, they can be but little used by the copepod, and the genera (*Pseudocaligus*, *Alebion*), in which they are reduced to mere rudimentary stumps, can not suffer much inconvenience from their loss. The muscles of the alimentary canal and those used in respiration have been already described.

NERVOUS SYSTEM.

The nervous system is composed of two central ganglia and the paired nerves which arise from them. One ganglion lies above the œsophagus and the other below it, but the lateral commissures connecting the two are so large that it would be more strictly correct to speak of the ganglia as fused together with a small opening through the center for the passage of the œsophagus (Pickering and Dana, p. 89). The upper, supracœsophageal ganglion or brain, is about half as large as the lower and gives off from its anterior end three pairs of nerves (fig. 27).

The first or inner pair (1) are optic nerves and arise from a small optic lobe produced on the dorsal surface of the ganglion.

They are very short and their roots cross so that each eye is supplied by fibers from both sides of the brain.

In *Lepeophtheirus* the second pair (2) arise just outside the first and go to the first antennæ. They are much larger than the preceding pair and subdivide into a number of branches, which supply both the plumose setæ upon the basal joint and the simple tactile setæ upon the terminal joint. From the size of this nerve and the detail with which every seta is innervated it is very evident, as A. Scott has well stated, that these first antennæ are important sensory organs. A branch from this second pair of nerves extends inward to the gland which secretes the filament for attachment during the chalimus stage. This branch is not noted by Scott, but is mentioned by Pickering and

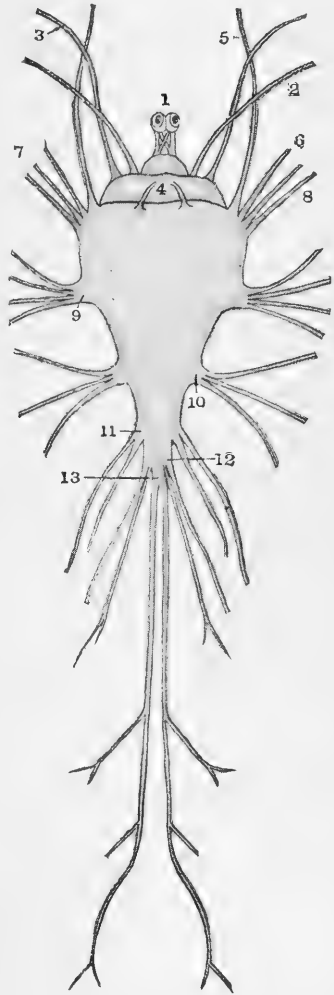


FIG. 27.—NERVOUS SYSTEM OF A LEPEOPHTHEIRUS. (AFTER A. SCOTT.)

Dana; but the latter are, of course, mistaken in interpreting the gland itself as nervous tissue. Furthermore, the second nerves in *Caligus curtus* (fig. 28, 2), which Pickering and Dana are describing, go, not to the terminal joints of the first antennæ, but to the frontal plates, and thus correspond with the fifth pair described by Scott. The present author has not had an opportunity to examine either of the species

described by these authors, but from an examination of other species of both genera it is fairly certain that the branch spoken of comes from the second pair of nerves, although its destination may vary slightly in different genera. The remaining third pair of nerves (3) arise from the angles of the ganglion outside the second pair and pass to the second antennæ. They are larger than the second pair, which would seem to indicate the importance of these second antennæ as organs of prehension. In their passage to the second antennæ these nerves pass under the second pair.

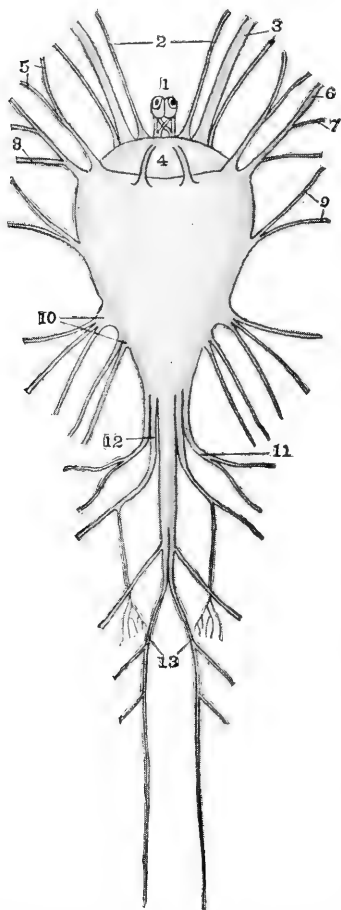
These are all that are given off by the upper ganglion. From the frontal and lateral margins of the lower ganglion arise seven pairs of nerves, while three other pairs are given off from the posterior end and form a sort of spinal cord, thus making thirteen pairs in all (fig. 28). The ten pairs from the lower ganglion supply the remainder of the appendages and the body muscles. The first of them, the fourth pair (4) in sequence, arise near the center of the anterior margin, and pass along the muscles of the œsophagus until they reach those of the mandibles near the base of the mouth. We have already

FIG. 28.—NERVOUS SYSTEM OF A CALIGUS.
(AFTER PICKERING AND DANA.)

stated that the mandible muscles were surprisingly large. These nerves are also of good size.

The fifth pair (5) have their origin near the anterior angle of the ganglion and pass forward to innervate the frontal plates, running under the nerves going to the first and second antennæ.

Three other pairs, the sixth, seventh, and eighth, arise close together in *Lepeophtheirus* at the anterior angle just outside the fifth pair. The sixth pair (6) innervates the first maxillæ, the seventh (7) the



second maxillæ, and the eighth (8) the muscles of the lateral area of the carapace.

The ninth nerves (9) arise from the anterior lateral margin as a single pair, each of which soon subdivides into four branches which go to the first maxillipeds and adjacent muscles.

The tenth pair (10) have their origin in the posterior part of the lateral margin and, subdividing into three branches, pass to the second maxillipeds. These nerves are very large and indicate again the importance of the appendages to which they go as prehensile organs.

At the posterior end of this ventral ganglion are given off the eleventh, twelfth, and thirteenth pairs. The eleventh pair (11), which are on the outside, go to the first legs and adjacent muscles. The twelfth or middle pair (12) innervate the second legs and the muscles of the thoracic area of the carapace. The thirteenth or inner pair (13) are so close together as to be distinguished with some difficulty. They extend backward side by side along the mid line of the body, through the free segment and into the genital segment, where they separate considerably, passing into the abdomen at about the centers of the right and left halves. Each nerve gives off a branch to the third and fourth swimming leg on its side, a large branch in the genital segment, which courses along the lateral margin and terminates in the fifth leg, and on entering the abdomen divides into two branches, one passing to the anus and the other to the anal lamina.

In *Caligus* the structure and arrangement of the ganglia and their nerves is almost identical with that in *Lepeophtheirus*, but the distribution as given by Pickering and Dana for *U. curtus* differs in several particulars.

Of the three pairs given off by the superior ganglion the first is the same, but the second goes to the frontal plates, while the third goes to the terminal joints of the first antennæ. On the inferior ganglion an extra pair arise close beside the fourth pair, which innervate the proboscis. The fifth pair go to the second antennæ instead of the frontal plates. All the other pairs are identical, save that the sixth, seventh, and eighth pairs are united at their roots and appear as branches of a single nerve rather than three separate pairs. There is also an extra pair close to the tenth which help to innervate the second maxillipeds. Thus, out of thirteen pairs ten are identical in the two genera, while the other three innervate the same regions but are interchanged, the nerve entering the frontal plates being first in *Caligus* and last in *Lepeophtheirus*.

It must be remembered that Pickering and Dana mistook the nature of several of the appendages, notably the antennæ. They understood that the first antennæ, or their rudiments, were situated in the central incision of the frontal plates, while the actual first antennæ they considered as the second, and they called the second antennæ the first

maxillipeds. Their judgment of the course taken by the several nerves may well have been biased by these mistakes. The present author has had no opportunity of verifying or disproving their statements by an examination of the same species.

The similarity in the structure and use of the appendages of all the genera here considered renders it probable that their innervation is practically the same, differing only in minor details.

REPRODUCTIVE ORGANS.

These consist in the female of a pair of ovaries, a long, more or less convoluted oviduct connected with each, a pair of semen receptacles, glands for secreting the material of the external egg cases and these cases themselves (fig. 29).

The ovaries (o) are large oval or kidney-shaped bodies situated on either side of the anterior portion of the dorsal surface of the stomach. When fully developed they extend from the first swimming legs to the base of the second maxillæ and can be plainly seen through the carapace in dorsal view. Each gives off an oviduct (o. d.) from the ventral surface at the anterior margin (fig. 30). This duct runs backward in nearly a straight line through the thoracic area, the free segment, and into the genital segment. As soon as it enters the latter it increases quickly in size and also becomes convoluted. The number and arrangement of the convolutions vary considerably in the different species as well as the genera, as may be seen by consulting figures.

In general, the convolutions attain their maximum number and size just before the extrusion of the external egg cases, and as soon as the latter are fully formed the

oviduct has become nearly straight. This condition is retained at least for some time subsequent to the hatching of the eggs and the throwing off of the egg tubes, since the adult females are often found in the condition shown in fig. 31.

On the ventral surface of the convolutions can be found an oblong, nearly transparent gland, closed at the anterior end, and at the poste-

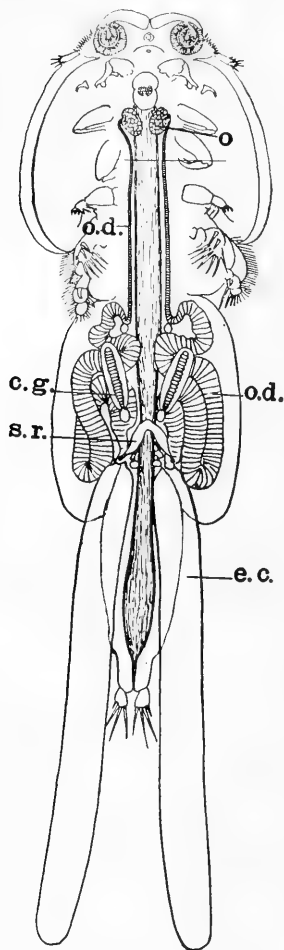


FIG. 29.—FEMALE REPRODUCTIVE ORGANS OF *CALIGUS BONITO*. (DRAWN BY EMERTON.) C. G., CEMENT GLAND; E. C., EXTERNAL EGG CASES; O, OVARY; O. D., OVIDUCT; S. R., SEMEN RECEPTACLE.

rior end connected with the oviduct just in front of the external opening. This organ is a cement gland (c. g., fig. 29) and secretes the material forming the external egg tubes.

This is undoubtedly "the flat, cylindrical organ, usually as broad as the external oviduct, and lying along the central portion of the abdomen," referred to by Pickering and Dana, and whose function they could not interpret.

Its shape differs considerably in the different genera and species, and will be described for each, so far as known.

The general features, however, are the same for all species. It consists of a long and flattened tube, which is decidedly club-shaped in most species rather than cylindrical. It is usually inclined inward toward the mid line and reaches forward nearly to the anterior margin of the genital segment.

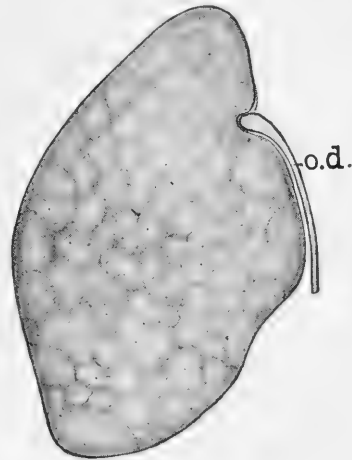


FIG. 30.—OVARY OF *CALIGUS BONITO* ENLARGED. O. D., OVIDUCT.

The lumen of the tube is narrow and surrounded by a very thick and transparent wall. It is further divided into flattened cells by transverse partitions, the cells being strongly rounded at the edges and thus looking very similar to the eggs. So great is this resemblance that the glands, though perfectly visible in many species, are easily mistaken for a part of the convolutions of the oviduct. But they can be easily distinguished by the fact that in most species the central lumen is considerably narrower than the oviduct, while in all species the anterior end is closed.

In sections the ovary is seen to be made up of a long, narrow tubule coiled up into a dense snarl or skein. The tubule is made up of a structureless membrane lined with germinal epithelium. The latter gives rise to the eggs, which are formed in the

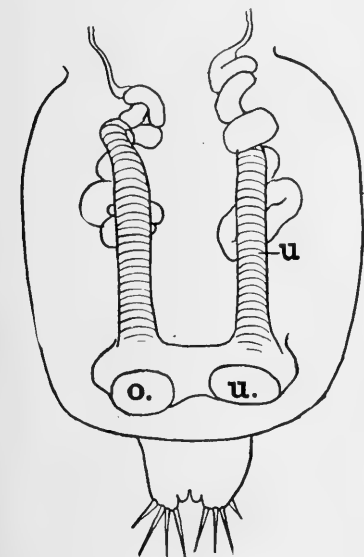


FIG. 31.—GENITAL SEGMENT OF *LEPEOPHTHEIRUS EDWARDSI* JUST AFTER THE HATCHING OF THE EGGS AND THE THROWING OFF OF THE EGG-CASES. O. U., OS UTERI; U., UTERUS.

lumen of the tubule, and which, when sufficiently developed, break through the walls and pass into the oviduct.

At first they are very small, simply nucleated cells, transversely oblong, and not quite filling the lumen of the narrow portion of the duct (c, fig. 32). As they pass backward they increase in size and gradually acquire a vitelline membrane somewhere in the posterior thoracic area. The cell contents also become finely granular with yolk particles, so that on emerging into the genital segment and suddenly increasing in diameter, the cells fuse somewhat and appear as a continuous granular mass in which it is practically impossible to distinguish either cell walls or nucleus (g, fig. 32). Very quickly, however, this

mass begins to differentiate again into separate eggs, in each of which the yolk or nutrient material separates from the white or animal material. The eggs are now flattened together more and more strongly through the pressure generated by their growth and finally become biscuit-shaped as they approach the external opening (b). This posterior portion of the oviduct is called by Rathke the uterus (u, fig. 31), and Claus remarks that the name is well applied, since the eggs remain here a long time. The oviduct is considerably narrowed just before reaching the external opening, and the eggs must be altered in shape as they pass through. During the passage each egg is fertilized by sperm from the sperm receptacles, whose duct opens into the

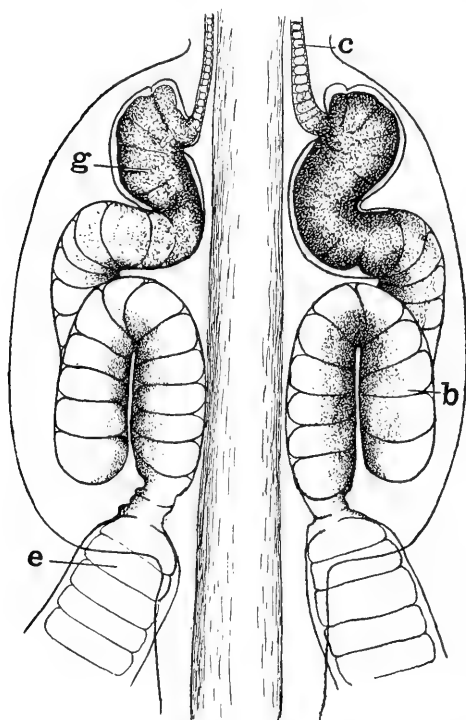


FIG. 32.—GENITAL SEGMENT OF *CALIGUS RAPAX*. b, EGGS FULLY FORMED AND READY TO BE PUSHED OUT INTO THE EGG CASES; c, EGGS AS SIMPLE NUCLEATED CELLS WITHOUT ANY YOLK; e, EGGS AFTER EXTRUSION AND FERTILIZATION; g, EGGS FUSED TOGETHER JUST AFTER ACQUIRING THE YOLK PARTICLES.

oviduct very close to the external opening.

This opening of the oviduct to the exterior, which to follow out the nomenclature of Rathke and Claus might well be called the os uteri (o. u., fig. 31) is situated on the ventral surface of the genital segment very close to the posterior end, and usually just above the rudimentary fifth legs.

On emerging to the exterior the eggs suddenly widen to nearly twice their former diameter, and are correspondingly diminished in

length (e., fig. 32). In addition to forming a cylindrical tube in which the eggs are arranged like a roll of lozenges, the cement gland also pours out a layer of its secretion between every two adjacent eggs. This forms a membranous partition and divides the egg tube into a series of narrow compartments, in each of which is a single egg, which does not quite fill the space, leaving room for the subsequent development of the larva.

The spermaries or sperm receptacles (s. r.) consist of a sack on either side extending from the os uteri obliquely inward and forward to the median line where it joins its fellow from the opposite side (fig. 33). A canal, the vagina (va.), leads diagonally backward and inward from the center of the posterior margin of each sack and opens to the exterior on the posterior margin of the genital segment along-

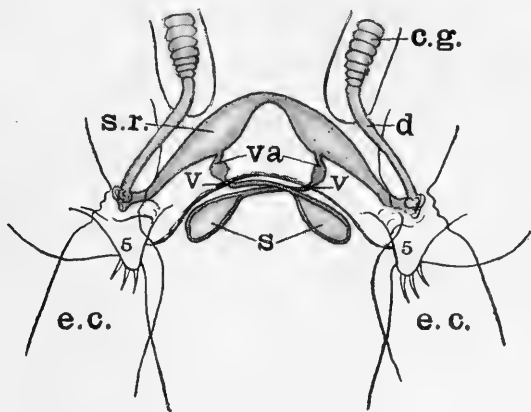


FIG. 33.—SEMEN RECEPTACLES AND VAGINA OF A FEMALE *LEPEOPHTHEIRUS*. (PARTLY AFTER CLAUS.)
c. g., CEMENT GLANDS; d, CEMENT GLAND DUCT; e. c., EGG CASES; s, SPERMATOPHORES; s. r., SPERMARIES; v, VULVA; va., VAGINA; 5, FIFTH LEGS.

side the mid line. This is the vulva or sexual opening (v.) and just inside it the vagina is enlarged considerably for the reception of the spermatophores (s.). These spermatophores are white in color for nearly all the species. They do not always enter the vulva, but may often be found upon the external surface, usually in the immediate vicinity of the vulva but sometimes elsewhere. On species like *Lepeophtheirus edwardsi* and *Caligus rapax* which are well pigmented they show up very prominently against the dark background.

A single copulation takes place just after the close of the chalimus stage, and at that time these semen receptacles are filled by the male. Their contents probably suffice for the fertilization of all the eggs the female lays, during her entire life.

The sexual organs of the male are very similar in position and arrangement to those of the female (fig. 34). They consist of a pair of

testes, a long vas deferens leading from each, and a pair of spermatophore receptacles in the genital segment. The testes (t.) are ovate or conical bodies situated in positions corresponding exactly to those of the ovaries.

They are considerably smaller than the ovaries and each gives off from its anterior end a duct, the vas deferens (v. d.), which leads directly backward without any convolutions into the genital segment. Here it enters the outer border of the spermatophore receptacle (s. r.)

at or posterior to its center. Each receptacle is oval or elliptical in shape, situated about in the center of its own half of the genital segment, and opens to the exterior near the posterior angle of the segment. On the ventral surface of the receptacle, or a little to one side of it, is a small cement gland (c. g.) which secretes the viscid substance composing the covering of the spermatophore.

In the receptacles the sperms are gathered into oval spermatophores, each of which is covered by the viscid secretion from the cement gland, in which condition they are pushed out of the receptacle and into the vagina of the female. As A. Scott remarks, the spermatophores do not always reach the vagina, and being viscid they stick to the female's body wherever they may touch it. We thus often find them scattered in little bunches or clusters in various places all over the ventral surface in among

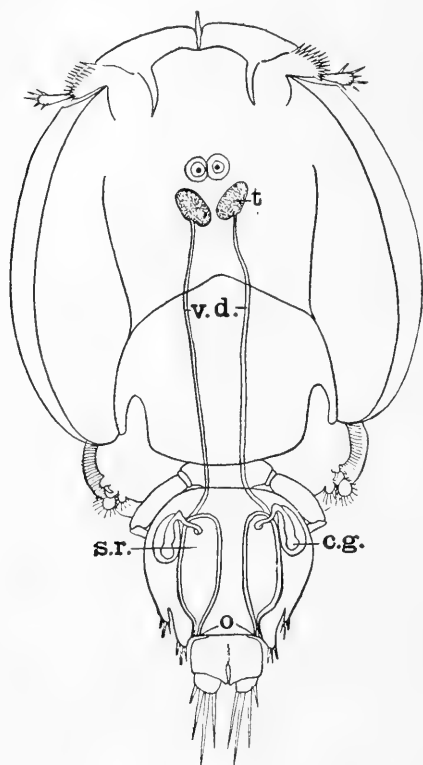


FIG. 34.—SEXUAL ORGANS OF A MALE *LEPEOPHTHEIRUS EDWARDSI*. c. g., CEMENT GLAND; o., OPENING OF THE SPERMATOPHORE RECEPTACLE, s. r., TO THE EXTERIOR; t., TESTIS; v. d., VAS DEFERENS.

the appendages. This was probably what the earlier observers mistook for eggs, after they had decided that the true egg sacks were antennae.

SUMMARY.

1. The body wall is made up of three layers, the outside cuticle, the median cellular tissue, and the inner connective tissue which forms a lamina supporting the various organs.

2. The alimentary canal is practically a straight tube running from the mouth to the anus, with the regions but slightly differentiated in

structure. It is made up of a narrow œsophagus, a very much wider stomach, a long and wide intestine, and a short and narrower rectum. Connected with the canal are two pairs of digestive glands, one pair in the anterior portion of the carapace near the margin, and the other in the thoracic area near the mid line.

3. The alimentary canal is constricted at fairly regular intervals, and in the living animal is in almost constant peristaltic movement, the waves passing alternately backward and forward.

4. There is no heart nor any organs of circulation. The blood is driven about through the lacunæ between the internal organs by the peristaltic movements of the alimentary canal just referred to, and by the respiratory movements of the rectum. In *Caligus curtus* Pickering and Dana discovered valvular action at two points, the apex of the posterior thoracic joint and between the basal joints of the second antennæ. No valves have been thus far seen in other species.

5. Respiration is anal, the posterior portion of the rectum being supplied with the necessary muscles for the pulsating movement.

6. The muscular system is very highly developed, and can be seen clearly through the transparent covering. All the muscles are plainly striated.

7. The nervous system consists of a supra- and an infra-œsophageal ganglion connected by stout commissures, and the paired nerves arising from them. There is no spinal cord nor any ventral chain of ganglia.

8. The female reproductive organs consist of a pair of ovaries situated on either side of the dorsal surface of the stomach. From each an oviduct leads back in nearly a straight line into the genital segment where it is strongly convoluted, and finally emerges to the exterior at the posterior margin of the segment. The oviduct is narrow at first and the eggs are simple nucleated cells. On entering the genital segment the duct widens suddenly and its contents become finely granular with yolk particles, and more or less fused. But the eggs quickly separate and clear in the convolutions, and finally emerge in a long, single row of lozenge-shaped forms, each occupying an apartment of its own in the external egg cases. The eggs are fertilized as they issue from the genital segment by sperm from a pair of sperm receptacles situated in the posterior part of that segment.

9. The male reproductive organs consist of a pair of testes smaller than the ovaries, but situated in an exactly similar position. From each a vas deferens leads back into the genital segment, and there enters one of a pair of spermatophore receptacles situated in the center of each half of the segment.

Here the sperms are gathered into bunches or spermatophores, covered with a viscid substance, and in this condition they are subsequently squeezed out of these receptacles into the vagina of the female.

SYSTEMATIC.

HISTORICAL.

The first which can really be called a classification of the parasitic copepods was made by Burmeister in 1833 and included only 23 out of the 80 and more genera known at the present day.

The group was divided into families on the basis of the presence and structure of the antennæ and segmented feet.

Each family was divided into genera upon a different basis, that for the Caligidae consisting in the presence or absence of eyes and the structure of the fourth thoracic feet.

The next important classification was by Milne Edwards in his great work on the Crustacea in 1840. He raised the number of genera of these parasites to 35 and divided them first according to the fusion of the head and thorax, and the structure of the antennæ. They were then subdivided by the presence or absence of dorsal plates on the free thoracic segments, while the Caligidae were classified by the structure of the fourth legs. This resulted in throwing all the forms with dorsal plates on the thorax into the Pandarinae, irrespective of their relations in other particulars.

As there were only 9 genera known at that time in the Caligidae, 2 of which, *Chalimus* and *Nogagus*, were spurious, such a division answered well enough, and it located each genus just where it stands at the present time.

A third classification was published by Steenstrup and Lütken in 1861, and by Nordmann in 1864, the two being identical.

They increase the number of genera to 68, of which 20 belong to the Caligidae; they divide them first according to the structure of the egg sacks and the arrangement of the eggs.

The second subdivision is on the basis of the degree of fusion between the head and thorax, and on the presence or absence of a carapace. In the family Caligidae the classification is based on the structure of the fourth feet, the presence of dorsal plates on the free segments of the thorax, and the presence of lunules on the frontal plates.

Heller, in 1865, adopted practically the same classification, but gave a much more elaborate analysis of the genera belonging to the Caligidae, which he increased to 26 in number.

For this analysis he makes use of (1) the structure of the rostrum and "palps" (second maxillæ); (2) the degree of fusion between the head and thorax; (3) the presence of dorsal plates on the free thorax segments; (4) the presence of lunules; (5) the structure of the fourth thoracic feet.

In the following year, 1866, there appeared the first number of Bronn's *Thierreich*, in the fifth volume of which, under the Copepoda,

Gerstaecker published several years later another attempt at the systematization of this group. His classification is based almost entirely upon the structure of the appendages and the genital segment, and has remained the accepted classification up to the present time. For the paper published by Bassett-Smith in 1899 can scarcely be called a classification; it is rather an enumeration of species with portions of the synonyms.

In Gerstaecker's work there are certain errors which can be corrected, and additions which must be made in order to bring the group up to date. The latter is especially true of North American genera and species, several of which were omitted by Gerstaecker through lack of identification.

The name also, *Nogagina*, which he suggests for his second subfamily, is very unfortunate since the genus called by older zoologists *Nogagus* is really made up entirely of the males of other genera. Hence it has no right to be continued at all, much less to be taken as the type of a subfamily. Any attempt to preserve this old genus must be really the introduction of a classification based entirely upon males into the midst of another which considers both sexes equally.

Furthermore it does not seem that Gerstaecker's arrangement shows as clearly as might be done the gradual transition from non-degenerate forms like *Caligus* and *Lepeophtheirus* through those which show the beginnings of degeneration, like *Gloiopotes* and *Alebion*, down to *Pandarus* and *Cecrops* which are manifestly quite degenerate.

The monograph published by J. D. Dana in 1852 on the Crustacea of the Wilkes Exploring Expedition contains the only attempt at a classification of the parasitic copepods thus far made by an American. He divides the group into three tribes according to the structure of the cephalothorax, the presence of a carapace, and the structure and arrangement of the thoracic legs. He separates the second of these tribes, the Caligoidea, into three families according to the segmentation of the first antennæ and the structure of the maxillipeds. The second family, the Caligidae, he subdivides into four subfamilies on the structure of the mouth parts and the external egg tubes.

The classification here presented, like all its predecessors, appropriates the best in those which have gone before, especially that of Gerstaecker, adds the new genera and species up to date, and such North American forms as have been omitted. It can not claim originality since it differs chiefly in arrangement, but it is hoped that this change in arrangement will show better than heretofore the relationships between the genera.

FAMILY CALIGIDÆ.

Carapace broad and usually compressed. Cephalothorax incompletely segmented, the free thoracic segments often partially overlapped or hidden by dorsal plates. Anterior antennæ short, club-shaped, with two or three free joints, their basal segments anchylosed with the anterior border of the carapace. Posterior antennæ in the form of a simple hooked claw, not extending beyond the carapace. Mouth in the form of a more or less elongated suctorial beak, formed out of the upper and under lips and inclosing the toothed mandibles. Maxillæ free, both pairs rudimentary, the first pair sometimes lacking. Maxillipeds also free and in the form of hooked claws, the first pair weak, the second much stronger and used for prehension. First four pairs of thoracic legs usually biramose, but the first and fourth pairs frequently uniramose; the fifth pair rudimentary and often invisible dorsally or entirely lacking. Two simple eyes fused on the median line, often lacking. Generative organs paired in both sexes; females with two cord-like egg tubes, usually quite long; eggs in a single row. Male usually smaller than the female and both sexes permanent parasites upon fish.

1. Three anterior segments of thorax fused with the head; fourth and genital segments free.....2.
1. Two anterior thoracic segments fused with the head; third, fourth, and genital segments free.....Subfamily TREBINÆ.
1. First thoracic segment only fused with the head, the others free; one or more of them with paired dorsal plates; all four pairs of legs biramose.....3.
2. Fourth segment without dorsal plates or any appendages except the fourth legs.....Subfamily CALIGINÆ.
2. Fourth segment with a pair of dorsal plates which usually overlap the genital segment.....Subfamily EURYPHORINÆ.
3. Frontal plates distinct; egg cases visible their entire length.
.....Subfamily PANDARINÆ.
3. Frontal plates fused with the carapace; egg cases convoluted, entirely hidden.
.....Subfamily CECROPINÆ.

The genera belonging to the Caliginæ are discussed in the present paper; those belonging to the other subfamilies are left for subsequent papers.

Subfamily CALIGINÆ.

Carapace broad and always flattened dorso-ventrally; free thorax segment without plates or appendages of any sort except the fourth pair of legs. Genital segment enlarged, but usually smaller than the carapace; never much larger except in the genus *Echetus*. First and fourth thoracic legs uniramose, second and third biramose; fifth pair rudimentary but often visible as a pair of small papillæ at the posterior corners of the genital segment. Adults active, most of the females as well as the males capable of swimming about freely.

KEY TO THE GENERA.

1. First and fourth thoracic legs uniramous; second and third pairs biramous....2.
1. First legs only uniramous; second to fourth biramous; frontal plates without lunules.....*Calistes* (Dana, 1852).
1. Fourth legs only uniramous; first to third biramous; no lunules; genital segment with two horny, dentate processes, as in the genus *Pandarus*.
Calina (van Beneden, 1892).
1. All four pairs of thoracic legs biramous; rami two-jointed; no lunules.
Dysgamus (Steenstrup and Lütken, 1861).
2. Frontal plates provided with lunules; second maxillæ simple, spine-like....3.
2. Frontal plates without lunules; second maxillæ bifurcate or simple.....7.
3. Genital segment simple, without plates or processes, and not elongated....4.
3. Genital segment without plates but prolonged posteriorly into processes nearly as long as the abdomen.....6.
3. Genital segment surrounded by a two-lobed membranous wing; abdomen with wings also.....*Parapetalus* (Steenstrup and Lütken, 1861).
4. Free segment short; genital segment usually smaller, never much larger, than carapace, and flattened.....5.
4. Free segment produced into a long neck; genital segment many times larger than carapace, cylindrical.....*Echetus* (Kröyer, 1863), p. 611.
5. Fourth legs normal; furca and first maxillæ present and well defined.
Caligus (Müller, 1785), p. 555.
5. Both furca and first maxillæ wanting; host, the mollusk *Nautilus*.
subgenus...*Anchicaligus* (Stebbing, 1901).
5. Fourth legs rudimentary, consisting of basal joint only, no exopod.
subgenus...*Pseudocaligus* (A. Scott, 1901).
5. Carapace proportionally very small; genital segment elongated; abdomen longer than rest of body; second maxillipeds large and massive.
subgenus...*Scienophilus* (van Beneden, 1852).
6. Four of these processes; the free segment short.
Synestius (Steenstrup and Lütken, 1861).
6. Only two processes; the free segment prolonged into an elongate neck.
Caligodes (Heller, 1865), p. 608.
7. Genital segment simple, without plates or processes.....8.
7. Genital segment without plates, but prolonged posteriorly into two processes twice as long as the segment itself; second maxillæ simple; no furca.
Diphyllogaster (Brian, 1899).
7. Genital segment covered with a fused dorsal plate extending backward over part of the abdomen.....*Homoiotes*, new genus, p. 661.
8. Carapace horizontal, not folded; abdomen normal.
Lepeophtheirus (Nordmann, 1832), p. 615.
8. Carapace normal, not folded; abdomen entirely wanting.
Anuretes (Heller, 1865), p. 647.
8. Carapace deeply incised at the center anteriorly; the two sides folded together.....*Hermilius* (Heller, 1865).

ONTOGENY.

The life history of the various genera here included is practically identical, so far as it is known. The development of the egg up to the time it is extruded has already been given, and we have seen that each egg was fertilized as it passed out.

Since the egg tube is secreted only as there is a demand for more space and is extended by the pressure of the issuing eggs, it follows that this pressure, acting always along the axis of the egg tube, flattens the egg at right angles to that axis. Each egg assumes a biscuit shape, with the exception of the one first extruded, which is hemispherical.

The form is usually fairly symmetrical, the pressure being equally distributed, but sometimes an egg will get flattened on one side more than the other (see fig. 2).

The germinal area is about in the center of the proximal side of the biscuit in the great majority of cases. But here again there are exceptions and occasionally an egg is reversed as it issues and the germinal area appears at the center of the distal side. From this center the embryo spreads gradually until it covers the flattened side and extends down over the edge of the biscuit, so that in advanced development the appendages can be distinctly seen on the edges of the eggs under a high power (see fig. 35). Not only are the germinal areas thus all upon the center of the proximal sides of the eggs, but the symmetry is carried still farther in the fact that the longitudinal axes of the embryos are very closely parallel. This brings the corresponding appendages of the different embryos in longitudinal rows along the sides of the egg tubes.

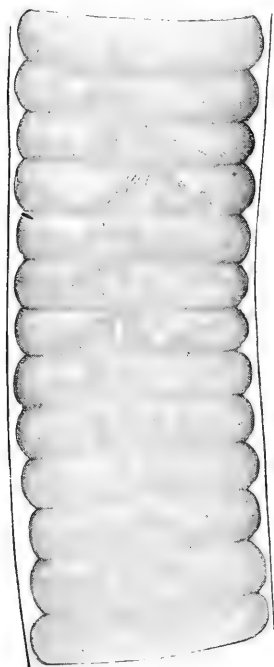


FIG. 35.—PORTION OF AN EGG-STRING OF *CALIGUS BONITO*. (HIGHLY MAGNIFIED.)

The eggs also change in color with advancing development. At first colorless or with a yellowish tint, they gradually assume the color of the pigment which is to distinguish the nauplius when it finally becomes free.

This color varies in different species and is readily visible to the naked eye against a white background for some time previous to hatching. If the living copepod be placed in a porcelain dish and examined with a hand lens the color shows to good advantage. It is so constant in the same species and so distinct in many of them as to afford a good supplementary evidence of identity in females carrying fully developed eggs.

There is no regular breeding season. Females with fully developed eggs are found alongside those with egg strings only partially extruded or with none at all. And oftentimes a single fish will yield these different adult forms and several chalimus stages. But while there is this great irregularity in the breeding season of different individuals,

the period of incubation is approximately the same for all members of the same species. And so far as known it does not vary much in different species, although no judgment of value can be drawn on this point without more extended observations. Eight weeks is required in *Caligus rapax*, and from eight to ten weeks in *Lepcophtheirus pectoralis*.

Hence while the stage of development reached by the various individuals found on any given fish may be widely different they are just as likely to correspond closely. And there are certain times when a given stage of development is more likely to be found than at others. Nearly all the chalimus stages used in the present paper were obtained from common flounders caught between the middle and the last of August at Casco Bay on the Maine coast. The season would be a little earlier in the vicinity of Woods Hole.

Again the whole of the embryos in the egg tubes of a given female hatch at practically the same time, only an hour or two between the first and the last. This greatly facilitates the rearing of the embryos through successive moults, as the material requires very little sorting.

If a female is captured with eggs nearly but not fully ripe it is practically certain that the embryos will issue before the mother's death. But of course in such cases the percentage of survival is extremely limited. If it is desired to rear the embryos females should be selected whose egg tubes have the deepest color, and an almost total failure may be simply due to the immature condition of the eggs and not to the environment.

Usually each egg ruptures separately, and the inclosing membrane of the egg tube splits opposite the egg, allowing the nauplius to wriggle out. There is thus a break in the tube for each of the eggs and nearly all the breaks are on one side, but in spite of this the empty cases are usually left still attached to the female after the last larva has escaped. But sometimes, in the haste preceding the death of the mother, when there is scant time for the hatching, or when the eggs lack considerably of being fully ripe, the result is very different.

The struggles of the nauplii in freeing themselves first break the tubes off from the genital segment of the mother and then tear them all in pieces, leaving nothing but fragments scattered far and wide.

As soon as they are fully free the nauplii swim to the surface and toward the light. Each has the typical nauplius form, ovate or elliptical in outline, strongly flattened dorso-ventrally, and with three pairs of appendages representing the first and second antennæ and the mandibles (fig. 36). The body is very simple and without segmentation, being made up of a cellular exterior surrounding the general body cavity, through the center of which passes the primitive digestive tube.

The latter consists of a mouth opening on the ventral surface just behind the bases of the first two pairs of appendages, and a straight tube with no differentiation of parts.

In the body cavity is a fluid representing the blood which circulates somewhat. On the dorsal surface close to the anterior margin is the median eye and the first traces of the nerve ganglion. Both the eye and the dorsal surface of the ganglion are well pigmented. This ganglion represents practically only the future supra-oesophageal one and the esophagus does not pass through it. The infra-oesophageal portion of the ganglion (see p. 552) appears with the development of the appendages.

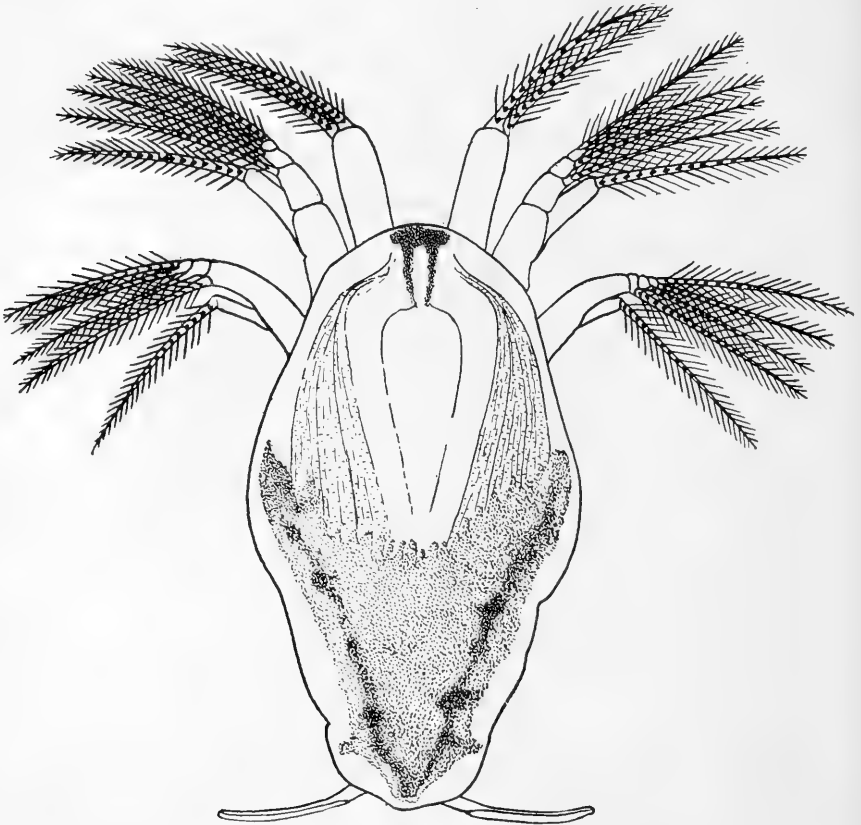


FIG. 36.—NEWLY HATCHED NAUPLIUS OF *CALIGUS RAPAX*, PIGMENT OF BRIGHT RUST COLOR.

The anterior part of the body is transparent and through it can be seen the muscles which move the appendages. They extend backward obliquely on either side from the bases of the appendages to the median line a little back of the center. They are faintly striated and very well developed, furnishing powerful motors for swimming.

The posterior portion of the body, a little less than half, still retains much of the nutritive material from the egg, by means of which the nauplius is to be nourished during several moults until it can seek a host and get its own food. These yolk granules make this portion of the body opaque and nothing of the internal structure can be seen

through them. On either side at the center are two large spots of the pigment, which characterizes the particular species. This varies decidedly in color and pattern in the different species thus far examined and will probably furnish a useful means of identification.

There are other much smaller spots of the same pigment, which vary somewhat in location in the different species, but are usually found, one on either side, close to the posterior end of the body, and a median unpaired spot just above the eye.

Of the appendages the first antennæ are uniramous and terminate in two long plumose setæ. They are often carried close together and pointing straight forward in front of the nauplius. The second

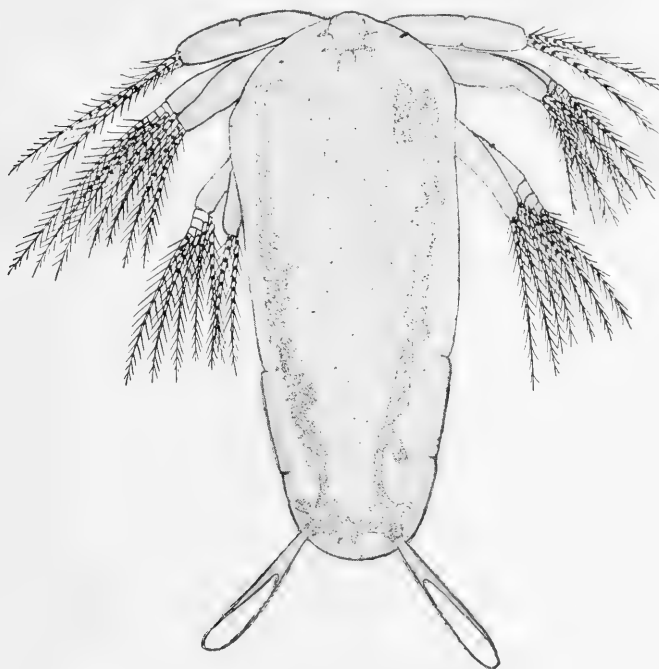


FIG. 37.—EARLY NAUPLIUS OF *CALIGUS BONITO*, DORSAL VIEW; PIGMENT CINNAMON BROWN IN A CONTINUOUS LINE AROUND THE MARGIN OF THE BODY.

antennæ and mandibles are biramous, the exopod four-jointed, each joint bearing a long plumose seta, the endopod with a single joint terminating in two similar setæ. These three pairs of appendages propelled by the powerful muscles already noted make efficient locomotor organs, and the nauplii move rapidly. And even at this early stage some difference can be seen between the nauplii of the different species. Those like *Caligus rapax*, which are very active in the adult form, begin this activity in the early nauplius, while others appear comparatively sluggish.

Near the posterior end of the body there is a pair of appendages

which usually point obliquely backward, and are of peculiar shape. Cylindrical at the base for about one-fifth of their entire length they then flatten antero-posteriorly and broaden slightly into the shape of a spatula or paper cutter.

They are not segmented and not readily movable; they seem to be used as a kind of balancing organ when the nauplii assume an upright position in the water on coming to rest.

The uniformity in the shape of these balancers as well as that of the body of the nauplii and the three pairs of appendages is good evidence of the close relationship of the genera here considered.

If a female be captured with eggs nearly or quite matured it is an easy matter to secure nauplii by keeping her over night in cool water. But to rear the nauplii successfully is a very different matter for many reasons.

In the first place they are extremely sensitive to even a slight rise in temperature and of course can not be kept in an aquarium of running water, and as they advance toward the chalimus stage they require freshly aerated water far more than in the nauplius stage, which it is exceedingly difficult to supply properly. A great many different methods have been tried, but the best success thus far has been obtained by keeping the larvæ in floating aquaria or bags of cheese cloth, immersed in the ocean. The mouth of the bag is open and it is floated at a sufficient height above the surface of the water to prevent the washing out of the larvæ.

As the latter naturally swim at the surface, this insures just the right temperature. And if they eat anything prior to the metanauplius stage, which is very doubtful, apparently enough food gets in through the meshes of the cheese cloth to keep them alive. In this way the nauplii of two species of *Caligus*, *C. rapax* and *C. bonito*, and one species of *Lepeophtheirus*, *L. edwardsi*, have been carried through several moults.

But of course when they reach the stage at which they would ordinarily fasten upon some host, all artificial methods fail, and we must depend for further material upon a careful examination of the fish's body. To achieve any success demands a knowledge of two things, the particular host or hosts preferred by any given parasite and the time of breeding. By securing a plentiful supply of the host just after the parasite's eggs have hatched one may be reasonably sure of finding some larvæ attached to them.

But obviously the securing of these early stages will require a very minute examination of every part of the fish's body, since the larva apparently fastens itself to the first place it happens upon, and may show no indications whatever of a preference for particular localities, which later in life becomes very marked. Especially is this true of such species as frequent the mouth and gill cavity. *Caligus bonito* in

the adult stage is never found on the outside surface of the body or on the fins, but those are the very places most easily accessible to the young metanauplius and where consequently it must be sought.

And then the larvæ are so small as almost to require a hand lens for recognition, and their color is so similar to that of the fish's body as to afford them ample protection.

About the only way to detect them in most cases is to take the fish directly from the water, and while it still retains a film of water over the entire outside of the body hold it up to the light in such a way as to get the rays reflected from the surface. The larva, being attached loosely, stands off from the surface and breaks the reflection. If the

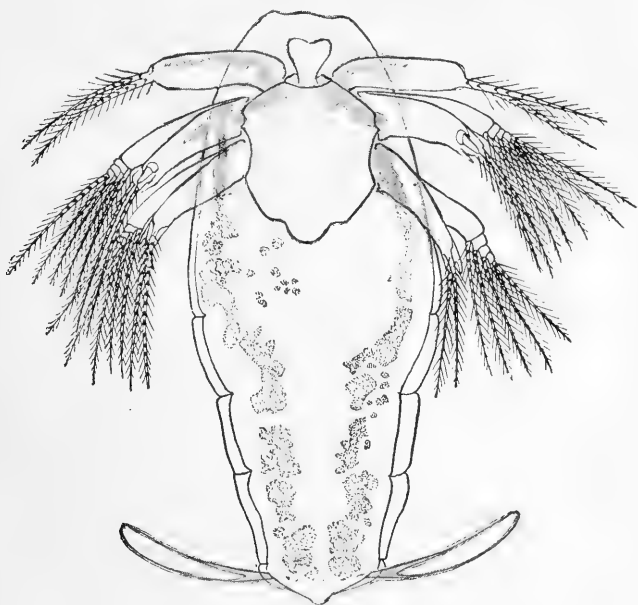


FIG. 38.—NAUPLIUS OF *CALIGUS BONITO* NEARLY READY TO MOULT INTO A METANAUPLIUS. THE PIGMENT, WHICH AT FIRST WAS IN A CONTINUOUS RING, IS NOW BROKEN UP. VENTRAL VIEW, SHOWING LABRUM.

fish has been dropped to the ground or into the bottom of a boat there is very little use to search it for development material.

In view of these difficulties it is not surprising that so few larval stages have been secured hitherto, or that investigators overlooked all but the largest and most advanced embryos.

As has been stated the nauplius at first is entirely unsegmented, with the three pairs of appendages grouped around the mouth near the anterior end of the body. The first moult occurs during the first thirty-six hours, usually in the night; the nauplius emerges with its body considerably elongated and with the evident beginnings of segmentation posteriorly. The division between head and thorax is plainly indicated in the clear edge which borders the carapace (fig. 37).

Behind this are two other sutures indicated in the same manner and also by perceptible grooves in the body wall itself. There are also traces of another joint farther back, very close to the balancers on either side. The pigment, which is characteristic of the species, and which at first was gathered more or less in the regions indicated, now spreads along the sides of the body, while the two spots near the anus fuse across the mid line.

The condition of this pigment as to whether it is a continuous line or a series of irregular spots varies greatly even in the same species; now the one condition prevails, now the other.

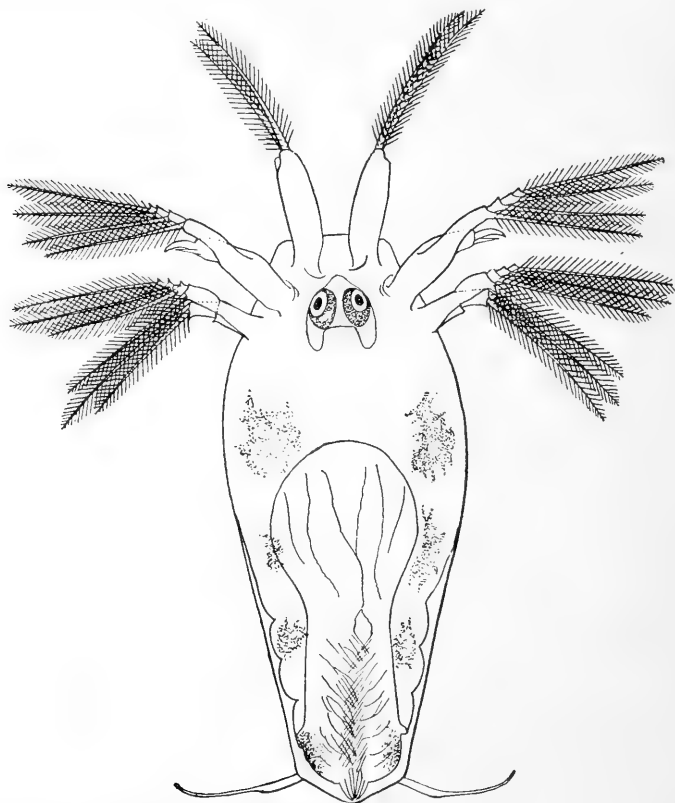


FIG. 39.—A NAUPLIUS OF *LEPEOPHTHEIRUS EDWARDSI* JUST READY TO MOULT INTO A METANAUPLIUS. THE NEW APPENDAGES CAN BE PLAINLY SEEN AT THE POSTERIOR END OF THE BODY.

The appendages remain unchanged, but between their bases on the ventral surface the huge shield-like labrum becomes more prominent. The spines also near the tips of the endopods of the two posterior pairs of appendages are larger than before the molt, and they show up plainly in a ventral view (fig. 38).

Hitherto the larva has been very active, but on getting ready for the second moult it becomes more sluggish and moves about slowly. It also pays less attention to the light and gradually seeks the bottom of

the aquarium. At the same time the first antennæ begin to show signs of segmenting into two joints, and upon the ventral surface of the posterior part of the body numerous fine lines appear curving from the outer edge inward and backward toward the anus (fig. 39).

These represent the setæ of the new appendages which are to appear with the second moult. This moult occurs during the second thirty-six hours and the larva comes forth radically changed in many particulars. The body has elongated more than 50 per cent, while it has broadened scarcely half that amount, with the result that it appears much narrower than before (fig. 40). The pigment now covers a wider space along the margin and is more uniformly distributed. The median nauplius eye has disappeared and instead we find the pair of simple eyes fused on the median line which are to characterize the adult. They are situated farther back in the carapace and in front of them a large mass of pigment extends the entire width of the carapace. This latter is much more clearly defined and now covers about two-thirds of the entire body. There are two free thoracic segments, each bearing the rudiments of a pair of swimming legs, and each more or less fused with the head.

They are followed by a third segment, and this in turn by an abdomen. The latter is short and terminated by a pair of blunt anal laminae (fig. 41). Each lamina carries on its inner margin a stout two-jointed seta. The shorter basal joint has a row of delicate hairs upon its inner margin, while the longer distal joint is plumose. Opposite this seta on the end of the lamina there is a long slender spine, and on the outer margin are three shorter curved spines.

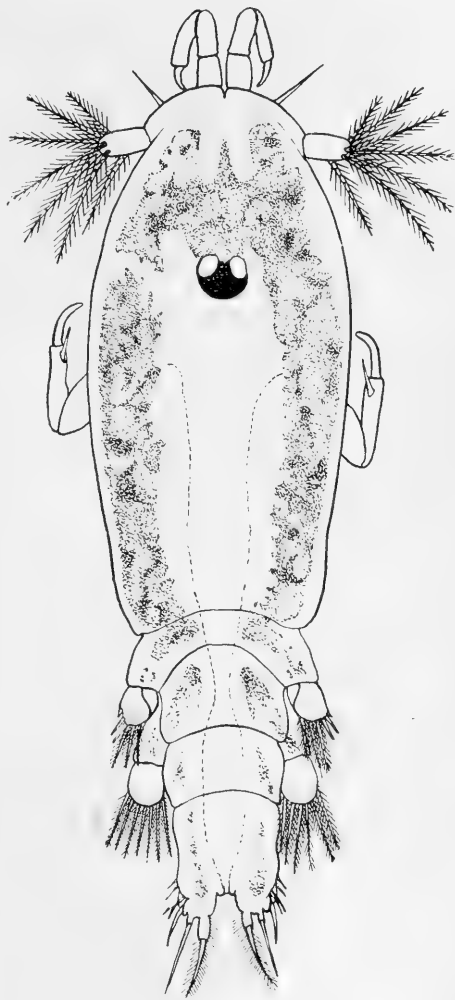


FIG. 40.—THE METANAUPLIUS OF *CALIGUS BONITO*, DORSAL VIEW. PIGMENT UNEVEN AND A RUSTY-BROWN COLOR.

This alters the appearance of the larva completely, but the greatest change has taken place in the appendages. The locomotor organs of the nauplius have entirely disappeared, and in their place stand appendages which are evidently the rudimentary forms of those found in the adult.

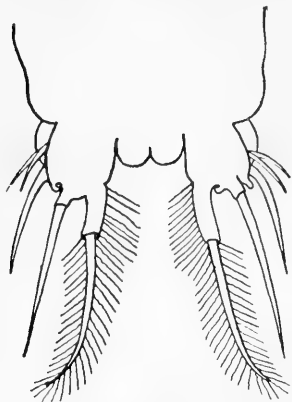


FIG. 41.—ANAL LAMINÆ OF THE METANAUPLIUS OF *CALIGUS BONITO*.

The first antennæ are now distinctly two-jointed, the basal joint carrying a single seta at about the center of its anterior margin, while the terminal joint is tipped with from seven to nine short plumose setæ irregularly arranged (fig. 40). Furthermore, instead of projecting directly forward in front of the body, as they did in the nauplius, these appendages are now appressed close to the anterior margin of the carapace. Their basal joints lie in exactly the position afterwards occupied by the frontal plates, and are already partially fused with the carapace. The

terminal joints, which are somewhat elongated, project at right angles to the body axis in the same position which they occupy in the adult.

The second antennæ have changed even more. They still retain their biramous character, but have become prehensile organs instead of locomotor (fig. 42). Each consists of a long and very stout basipod from which project the shorter terminal segments.

The latter are fused for a distance and then separate at nearly right angles. The exopod is considerably the shorter of the two and is terminated by a short rudimentary spine.

The endopod is much stouter and terminates in a single curved claw, nearly as long as the endopod itself, and bent over ventrally until its tip points in toward, and nearly touches, the ventral surface of the basipod. These are manifestly intended for clasping organs and in furtherance of that design they extend forward in nearly the same position as that



FIG. 42.—THE SECOND ANTENNÆ OF THE METANAUPLIUS OF *CALIGUS BONITO*.

occupied by the first antennæ of the nauplius. Moreover, the larva keeps snapping them viciously, giving a forward and downward rake in the evident endeavor to hook them into something. They must be

the organs by means of which the larva is to obtain its first hold upon its host.

Just posterior to their base is the mouth, which possesses the same framework and mouth parts as in the adult, although the mouth parts are not yet fully developed. On either side of the mouth, close to its base, are the second maxillæ, which are also very rudimentary (mx.", fig. 43). There is no basipod; the endopod consists of a single conical spine, longer and more slender than in the adult, while the exopod is made up of two small circular chitin plates close to the base of the spine.

The first maxillæ can scarcely be distinguished as minute protuberances close to the margin of the carapace opposite the mouth. The first maxillipeds (mxp.) are much shorter and stouter than in the adult, especially in the terminal joint. They are tipped with three strong spines or claws arranged in a row, the two inner ones being pectinated like the hind toe of a night-hawk's foot.

The second maxillipeds, on the contrary, are much longer and more slender than in the adult, and again this difference is most marked in the terminal joint and claw (mxp"). They are so much elongated that they project far beyond the edge of the carapace and stand out prominently in a dorsal view.

The claw, even at this early stage, is furnished with the small accessory spine on its inner margin, which is found in the adult.

Evidently these appendages are to serve with the second antennæ as prehensile organs. They are especially serviceable in this elongated state during the chalimus stage, as will be noted later. (See p. 546.)

Each of the two free segments of the thorax bears a pair of rudimentary, biramous appendages whose terminal joints are fringed with plumose setæ. It was these setæ seen through the skin of the nauplius which gave rise to the long curved lines on the ventral surface at the posterior end of the body just prior to this third stage. The appendages represent the first and second pairs of swimming legs of the adult, but differ much from their ultimate form. The basipods are very short and stout, wedge-shaped or oblong, and armed with short spines at their distal ends. The first pair are united across the mid line by a wide and

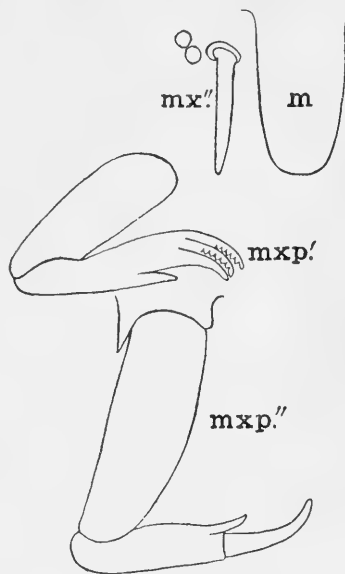


FIG. 43.—MOUTH-PARTS OF THE METANAUPLIUS OF CALIGUS BONITO. m, MOUTH; mx'', SECOND MAXILLE; mxp', FIRST MAXILLIPEDS; mxp'', SECOND MAXILLIPEDS.

strong sternum, which is thickened along its anterior edge (fig. 44). The sternum uniting the second pair is very short and is made up of two heart-shaped plates inclined toward each other and united at their tips and for some distance along their adjacent sides (fig. 45).

The endopods and exopods of the two pairs of legs are quite similar and each consists of a single joint, broadly lamellar and fringed distally with six large plumose setae, making them strong swimming organs. In the arrangement of these setae may be seen an indication of the future segmentation of the appendages. Upon the third free segment may be found a pair of small projections, unsegmented and unbranched, which are the rudiments of the third pair of legs. Each carries at its distal end several short spines.

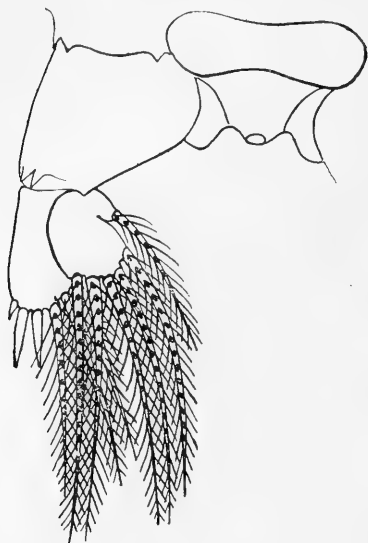


FIG. 44.—FIRST SWIMMING LEGS OF METANAUPLIUS OF CALIGUS BONITO. VENTRAL VIEW, SHOWING CONNECTING VENTRAL PLATE.

At the third moult, which occurs after about the same interval as the others, there is little advance save in a few changes toward the adult form. The first antennae now become three-jointed, the basal joints long and narrow and turned back on and articulated with the anterior margin of the carapace.

It is plainly evident that they are to become the frontal plates.

Between them, in the very front of the head, there appears a large median gland which secretes the material for attachment during the following chalimus stage. (See fig. 46.) This gland is heart-shaped, the larger end being anterior, and is close to the dorsal surface of the carapace. A duct leads from the gland to a point at the very tip of the carapace between the bases of the first antennae.



FIG. 45.—SECOND SWIMMING LEGS OF METANAUPLIUS OF CALIGUS BONITO. VENTRAL VIEW, SHOWING CONNECTING VENTRAL PLATES.

The second antennæ and second maxillipeds retain their prehensile function and have changed but little.

There has been a fusion of the first and a partial fusion of the second thoracic segments of the previous stage with the cephalo-thorax. The third segment has elongated; the rudimentary third legs have developed into a pair quite similar to the first and second pairs of the previous stage. Upon the posterior end of this segment appear another pair of rudimentary protuberances which are to develop into the fourth legs.

The genital segment still remains fused with the abdomen, and the two have increased considerably in size.

The time has now arrived for the larva to seek its host, and, when once found, it fastens immediately to the host's body. Just how the host is found remains a mystery, but certain facts are self-evident.

In the first place the nauplii and metanauplii swim freely at or very near the surface, while the fish which are to serve as their future hosts do not frequent the surface. None of the surface fish when examined are found infested with parasites of the genera here considered, with one or two exceptions. And these are forms which are peculiar to the fish on which they occur.

There is nothing, therefore, in the nature of an intermediate host; the larva does not fasten itself upon the fish which is nearest at hand and remain until it can seek its proper host.

It finds in some way at the very first the fish it wants and upon which it is to be found when fully developed.

Most of the genera here considered infest fish which live at or near the bottom, the Gadidæ, Pleuronectidæ, etc. And every form of development from the earliest metanauplius stage through to the sexually mature adults may be found upon the same species of fish by careful search at the right season.

At some time, therefore, during the two metanauplius stages the

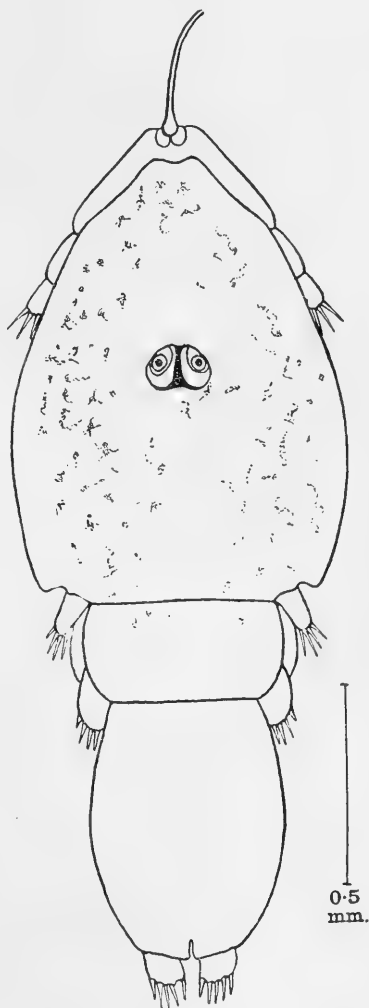


FIG. 46.—A YOUNG CHALIMUS OF CALIGUS RAPAX.

larva must leave the surface and seek the bottom, remaining there until it can fasten itself to a host.

The passage from the surface to the bottom must form one of the critical periods in its existence, and even after it gets there the chances are not very favorable for finding a suitable host within the brief time necessary.

These metanauplii seize the fish with their second antennæ, stretching them forward side by side and driving the terminal claws deeply into the fish's flesh through its skin.

The antennæ are so long and the hold obtained is so firm that the larva stands out from the surface of the skin in a manner very suggestive of the chalimus stage with its long frontal filament. Furthermore the antennæ, being very close together and along the median axis, allow almost as much freedom of motion as a single filament.

After one or two moults in this stage the larva emerges as a chalimus and puts in operation the median frontal gland with its secretion, which has been developed as a means of attachment. The way in which the larva handles this gland, produces the filament, and fastens itself to its host has never been directly observed. But the author was fortunate enough to see a young chalimus refasten itself after being torn away from the tail fin of a flounder. In all probability the original method was very similar, if not identical. The larva seized the fin with its second antennæ, piercing the skin and obtaining a good hold

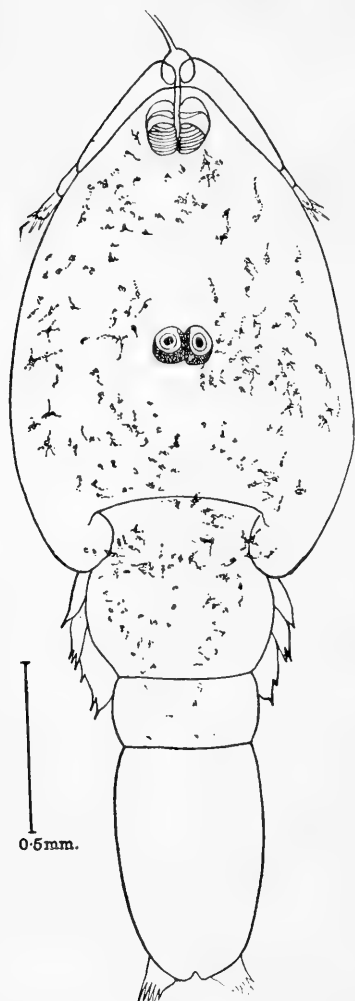


FIG. 47.—CHALIMUS OF CALIGUS RAPAX.
(THE NEXT MOULT AFTER FIG. 46.)

on the fin ray. The posterior part of the body was then raised upon the second maxillipeds, depressing the anterior margin until it touched the fin at the point where the duct from the median gland opens. The gland then poured out its secretion, which was thick and viscid, and stuck firmly to the fin ray. The carapace was moved about in such a way as to spread the secretion over a larger surface. The larva then released its hold with the antennæ and at the same time

seemed to push itself backward with its maxillipeds. In this way the secretion was pulled out into a long slender rod or cord, nearly as long as the body of the larva.

The secretion seems to harden instantly and furnishes a strong and very flexible means of attachment during the moults which intervene before the adult stage is reached.

If one of the fin rays be examined under the microscope the filament can be seen to penetrate the skin and to be attached along the side of the ray for some little distance, as noted by Scott (1901). Often the tip of the filament is spread out into a broad disc, giving it a firmer hold around the ray.

Just how the secretion is brought in contact with the fin ray could not be determined, but it has already been noted that the second antennæ, in grasping the fin, penetrated the skin and took hold on the ray. It seems probable that in spreading the secretion about some of it may enter the openings thus made and come in contact with the ray. Its own adhesiveness would be sufficient to fasten it securely on hardening.

In all the specimens collected the tip of the filament has been so firmly fastened to the host that it could not be detached. In every instance the filament either broke at the center or was torn out of the chalimus's carapace when an effort was made to detach it. And the only way to obtain the fastening intact is to cut off the ray and preserve it with the chalimus still attached.

The larva is frequently attached to a scale rather than a fin, and in such cases the filament pierces the cutis covering the scale and is flattened into a disk upon the surface of the scale itself. The idea in every instance seems to be the attachment of the distal end of the filament to something that will not give way. In rare instances the young may be found attached elsewhere upon the host, or even to some portion of the body of an adult parasite, as noted by Hesse (1858).

The chalimus can pull itself down to its host at any time by means of its long maxillipeds, and in this way obtain its food. The stage is one of great interest, both on account of this peculiar means of attachment and also historically.

Originally discovered by Burmeister, it was described by him in 1831 as a new genus of the Caligidæ, and several species were afterwards added by the same and other authors. But the more careful observers were quick to suspect its real relation to other members of the family, and Krøyer very early suggested that it was only the young of *Caligus*, or some closely related form. Müller (1852) and Stein (1852) soon proved this satisfactorily, and subsequently Hesse (1858), Gerstaecker (1859), and Nordmann (1864) confirmed the conclusion.

Of these writers Hesse had the notion that the mother voluntarily

attached the young to her own body, in order to render them material assistance. He describes the "filet" which fastens the embryo to its mother, and designates it as the "cordon frontal." It is long and flexible enough to allow the young an independent action and to permit it to apply itself to the fish upon which both the mother and the young live.

It is a very curious and interesting spectacle, says Hesse, to see these embryos, especially those of *Trebius* and *Caligus*, which swim with considerable facility, following the evolutions of their mother, like a small boat towed by a large ship. This liason of the two individuals ceases as soon as the young are able to procure their own nourishment, the rupture taking place about the time of the second or third moult.

This idea of voluntary attachment was strongly denied by Gerstaecker and Nordmann, while Stein, who wrote six years before Hesse, and whose work the latter entirely overlooked, also contended that such attachment is purely accidental. That this is the true interpretation is evident from many considerations.

In the first place the larvæ hatch as free-swimming nauplii, positively heliotropic, and therefore frequenting the surface, while most of the fish which are to serve as their hosts live at or near the bottom, as already noted. We have also seen that the larvæ moult at least three times before entering the chalinus stage, leaving the surface and becoming negatively heliotropic after the second moult. Hence each of them must seek out its own host, and there is not one chance in a thousand that it will find the same host upon which it was born.

And the probability of finding its own mother still upon that host would be even less. Indeed the finding of its own mother under any circumstances after a free-swimming period, no matter how short that period might be, presupposes, if the union is to be voluntary, an ability on the part of either mother or offspring to recognize the other! Such recognition would be at least an anomaly among parasitic crustacea.

But even if we grant that the larva might find its own mother, still the act of attachment can not be performed by the latter; it is wholly the work of the larva itself, as we have just seen, and must be controlled by instinct. And it could hardly be claimed that instinct guided the larva to the body of its parent, since this would necessitate some advantage to result from the union. Such an advantage would be difficult to prove, and even if it were established we should still have to explain the fact that only one or two larvæ out of thousands followed their instinct and availed themselves of the advantage. We can only conclude that such a union by no means proves a close relationship between the adult and the larva; that it is purely accidental and of rare occurrence.



FIG. 48.—CHALIMUS OF *CALIGUS RAPAX*. (ONE MOULT LATER THAN FIG. 47.)

The changes which take place during this fourth moult and those which subsequently occur in the several moults of the chalimus period are very suggestive in many ways.

The carapace, which is at first squarely truncated posteriorly (fig. 46) and decidedly spindle-shaped, gradually develops a lobe on either side and widens considerably into a form which is obovate or elliptical (fig. 48). The first three segments of the thorax fuse completely with

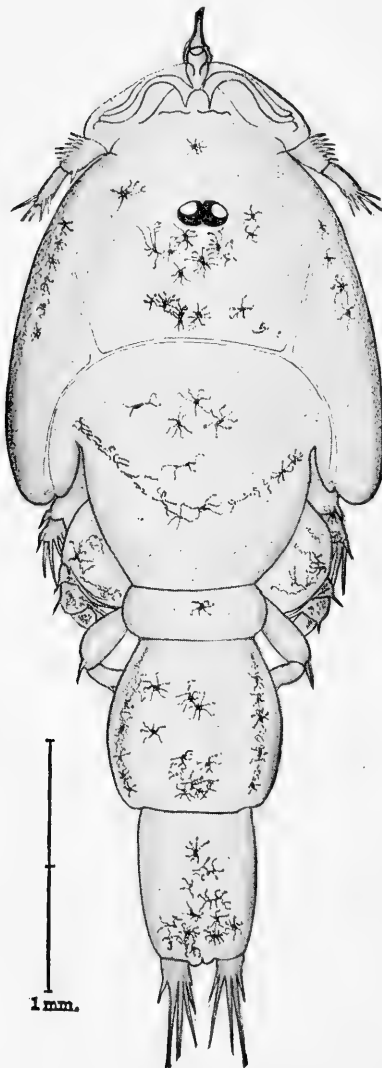


FIG. 49.—FULLY DEVELOPED CHALIMUS OF FEMALE *CALIGUS RAPAX* FROM FLOUNDER. DORSAL VIEW.

the head and the sutures, which subsequently separate the regions of the carapace, appear and become fairly well developed. The free segment of the thorax is still very long in the early chalimus stage, but rapidly shortens with every moult. The genital segment and the abdomen begin to separate by the second chalimus moult, the abdomen at first being several times the larger (fig. 47). But before the close of the chalimus stage the genital segment has increased until it is the larger, while the abdomen has narrowed somewhat, and the anal papillae with their setae have lengthened considerably (fig. 49).

The eyes in the early chalimus stages are relatively large and situated far back in the carapace, nearly at its center. They move steadily forward with every moult until they reach the adult position at a point about one-third of the length of the carapace from its anterior edge. But the appendages move forward at the same time so that the eyes remain all the while just above the mouth.

The first antennae still remain three-jointed, and in the later chalimus stages lunules gradually develop upon the basal joints in such species as are to possess them. This is the final proof that these basal joints become the frontal plates.

This fact, which has all along needed the testimony of development in order to demonstrate it fully, now that it is established, entirely changes the homology of the antennae. So long as the frontal plates were regarded as a portion of the carapace, no homology in structure or function between the antennae of *Caligus* and those of *Argulus* was

possible. But as soon as we recognize in the frontal plates the basal joints of the first antennæ, such a homology becomes not merely possible but very complete and significant. In both families the first antennæ are three-jointed, the basal joint being enlarged and modified to serve a prehensile function, while the two terminal joints are much smaller and wholly tactile. In *Argulus* the prehension is accomplished by means of a stout hook developed at the distal end of the basal joint, while in *Caligus* the same result is attained by a sucking disk or lunule.

The second antennæ in *Argulus* are largely tactile, only the basal joints being prehensile in function, and even these have nothing but stout spines to assist in preventing the copepod from slipping back-

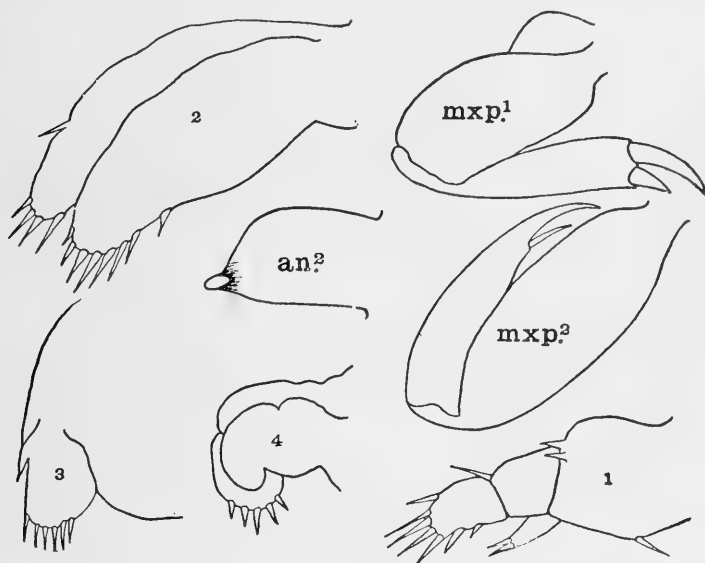


FIG. 50.—APPENDAGES OF THE EARLY CHALIMUS STAGE SHOWING MODE OF DEVELOPMENT. an^2 , SECOND ANTENNÆ; mxp^1 . AND mxp^2 ., MAXILLIPEDS; 1, 2, 3, AND 4, SWIMMING LEGS.

ward. But in *Caligus* the entire second antenna becomes prehensile (fig. 50, an^2 .), the basal joint with a stout spine pointing backward, as in *Argulus*, while the terminal joint is developed during the chalimus period into a strong sickle-shaped claw, operated by powerful muscles, and fully capable of rendering material assistance to the maxillipeds in piercing the skin of the host and obtaining a firm hold.

Both Baird (1850) and Pickering and Dana (1838) described these second antennæ as the first pair of foot-jaws, the former without making any comparisons, the latter claiming that they corresponded to the second maxillæ in decapod crustacea, a manifest error.

The first and second maxillæ develop somewhat toward the close of the chalimus period, but as they are rudimentary even in the adult no marked development is possible in the larva.

The other mouth parts and the four pairs of swimming legs develop steadily toward the adult form, with no marked changes at any one moult. The only features worthy of note are in the development of the first and fourth pairs of swimming legs.

In early stages the first pair (fig. 50, 1) have a well-defined endopod, much smaller than the exopod to be sure, and consisting of but a single joint terminating in two small setae. Later this rudimentary endopod almost entirely disappears, its place in the adult being indicated by a long, slender seta.

The fourth legs are made up at first of two short and very broad disk-like segments, totally unlike the long and slender adult form (4). Furthermore, there are no setae anywhere upon them except at the tip of the terminal joint where four very short and stubby ones stand in a row. With almost the first chalinus moult, however, the nature of these legs changes radically, and they quickly narrow and elongate, at the same time acquiring setae upon all the joints.

With the beginning of the chalinus period the digestive organs change into the adult form, and the reproductive organs appear. The latter grow rapidly in the male and have attained their full development by the close of the chalinus period, but in the female they remain rudimentary until fertilization, which takes place only after the larvæ have become free swimming. The genital segment in the female remains small, deeply lobed posteriorly, and with the fifth legs showing prominently for quite a long time after the close of the chalinus period.

The nervous system starts in a large ganglion just beneath the dorsal surface of the carapace, posterior to the eyes. This ganglion is elliptical in shape, the eyes being situated just above its anterior end. A pair of nerves, corresponding to the first pair in the adult, extend from the anterior end of this ganglion to the eyes. From the posterior end in early chalinus stages two or three pairs of slender nerves extend a short distance backward but do not reach beyond the carapace. This one ganglion evidently corresponds to parts of both the supra- and infra-oesophageal ganglia in later development. As the young copepod grows by successive moultings, and the various appendages appear in regular order, the nervous system also develops. In this way for each of the appendages there appears at the proper time the pair of nerves which are to innervate their muscles until the whole system is completed. After a study of these forms extending over several years it may be stated with a fair degree of accuracy that this period of attachment to the host lasts from four to six weeks. During that time, to judge from the material collected, there are at least five moults, if not more.

At the close of the period the appendages have become fully developed, and with the last moult the filament separates just at the

frontal margin of the carapace, leaving a notch where it emerged, and usually a portion of the filament itself projecting from the base of the notch and extending backward into the carapace to the gland. These remains persist all through the adult life and are an abiding evidence of the relation between chalimus and adult.

SUMMARY.

1. The eggs as they are extruded to the exterior in the egg tubes assume a biscuit shape with the germinal area at about the center of the proximal side. The embryos develop until they cover this side and extend down over the edges of the biscuit, their longitudinal axes being closely parallel.

2. As the embryos develop they become pigmented, the pigment varying in color and arrangement in different species, and in this way affording good supplementary evidence of identity.

3. Each egg ruptures separately, and the membranes of the egg tube split just opposite the embryos, allowing the latter to wriggle out, and leaving behind the membranous framework of the egg tubes the same size and shape as before and still attached to the female, but empty.

4. The nauplii swim to the surface and toward the light as soon as they are free. Each has a typical nauplius form, ovate or elliptical in outline, strongly flattened dorso-ventrally, and with three pairs of appendages representing the first and second antennæ and the mandibles.

5. The first antennæ are uniramous and terminate in two long plumose setæ. The second antennæ and mandibles are biramous, the exopod four-jointed, each joint bearing a long plumose seta, the endopod with a single joint terminating in two similar setæ. Near the posterior end of the body is a pair of spatula-shaped balancers.

6. The first moult occurs during the first thirty-six hours, usually at night; the nauplius emerges with its body considerably elongated and with the evident beginnings of segmentation posteriorly. The appendages remain unchanged.

7. The second moult occurs during the second thirty-six hours, also at night; the nauplius emerges radically changed. The median eye has disappeared, and instead we find a pair of eyes fused on the median line, as in the adult. The carapace is more clearly defined, and covers about two-thirds of the body; there are two free thoracic segments, each bearing the rudiments of swimming legs, followed by a third segment with even more rudimentary appendages, and this in turn by the fused genital segment and abdomen, the latter terminated by a pair of blunt anal papillæ armed with setæ. For appendages this larva possesses first and second antennæ, first and second maxillæ,

mandibles, a mouth tube or probocis, first and second maxillipeds, and three pairs of rudimentary swimming legs.

8. The third moult occurs at about the same interval as the others. The first thoracic segment has been entirely, and the second partially, fused with the head. The third segment has elongated and the rudiments of the fourth thoracic legs appear upon its posterior ventral surface. The genital segment still remains fused with the abdomen, but the two have increased considerably in size. The first antennae have become three-jointed; the other appendages remain unchanged, save that the swimming legs advance toward the adult form.

9. The larva now seeks its host and moults again into what is known as the *chalinus* stage, the chief characteristic of which is the development of a long cord or filament by means of which the young are attached to their host. This filament is made out of the material secreted by a median gland situated just in front of the eyes.

10. The changes which take place during this fourth moult and those which subsequently occur in the several moults of the *chalinus* period are in the line of gradual development toward the adult form. The carapace, at first squarely truncate posteriorly, gradually develops a lobe on either side and widens. The first three thoracic segments fuse with the cephalon, and the sutures on the dorsal surface of this cephalo-thorax appear and become well developed. The genital segment and the abdomen separate at the second *chalinus* moult, the abdomen at first being several times the larger. The eyes move steadily forward with each moult, but as the appendages on the ventral surface move forward also the relation of the two remains unchanged.

11. The only appendages worth noting are the first and fourth swimming legs. In the early *chalinus* stages the first pair have a well-defined endopod, consisting of a single joint terminating in two small setae. Later this disappears and its place in the adult is indicated, if at all, by a long seta. The fourth legs are made up at first of two short and broad, disk-like segments, without setae or spines. With successive moults they narrow and elongate into the adult form, and acquire both spines and setae.

12. This attached stage lasts from four to six weeks, and the larva moults at least five times. At the close of the stage the male is practically fully developed, but the female remains immature, so far as the reproductive organs are concerned, until fertilization has been effected and the ova begin to descend the oviducts. With the last *chalinus* moult the connecting filament separates just at the frontal margin of the carapace and the copepod enters upon its free adult existence.

GENUS CALIGUS Müller.

Carapace large, shield-shaped. Basal joints of the first antennæ provided with lunules; two terminal joints free, heavily armed with setæ. Mandibles often toothed along both margins. Second maxilla simple, spine-like. First and fourth thoracic legs uniramous, second and third biramous. Fourth thorax segment without dorsal plates; genital segment simple also, without plates or processes. Abdomen one to many segmented. The young of both sexes with a frontal filament for attachment during the chalimus stage. Anal lamellæ strongly flattened and armed with long plumose setæ.

(*Caligo*, obscurity, darkness.)

ARTIFICIAL KEY TO THE SPECIES.

The relative length of the different body regions is the most constant character available for classification of species.

Both sexes are here included, since they usually exhibit radical differences, and they must be sexually mature, although the presence of egg strings in the female is not necessary. When the fifth legs are spoken of as visible or invisible it means in dorsal view only, and has no reference to a microscopical examination of the ventral surface. All measurements of length include the anal lamelle, but not the plumose setæ upon them. Differences of length must amount to eight per cent or ten per cent; otherwise they are considered as "about equal." In any case where there might still be danger of mistake after this liberal allowance the species has been inserted twice. This key includes all valid species known at the present time. The authority for each species is here given, and the reference can be found in the bibliography on p. 666.

There have been eliminated the following species:

First, those which subsequent examination has shown to belong to other genera. Here are included *bicolor* (Lamarek, 1818), which is a *Pandarus*; *branchialis* (Steenstrup and Lütken, 1861), a *Lepeophtheirus*; *brevipedis* (B-Smith, 1896), a *Pseudocaligus*; *crassus* (Abildgaard, 1794), an *Anthosoma*; *gracilis* (v. Beneden, 1851), *hippoglossi* (Kröyer, 1837), *molæ* (Latreille, 1825), *nordmanni* (M-Edwards, 1840), *obscurus* (Baird, 1850), *ornatus* (Nordmann, 1832), *pacificus* (Gissler, 1883), *pectoralis* (Müller, 1785), *pharaonis* (Nordmann, 1832), *salmonis* (Kröyer, 1837), *sturgeonis* (Kröyer, 1837), *stromii* (Baird, 1850), and *vespa* (M-Edwards, 1840), all of which belong to the genus *Lepeophtheirus*. *Imbricatus* (Risso, 1816) is an *Anthosoma*; *oblongus* (Abildgaard, 1794) is a *Dichelestium*; *paradoxus* (Otto, 1828) is a *Demoleus*, and *smithii* (Lamarek, 1818) is an *Anthosoma*.

Second, those which have proved to be synonyms of species already described. Here are included *æglefini* (Kröyer, 1863), a male *curtus*; *americanus* (Pickering and Dana, 1838), also a *curtus*; *bengoensis* (T. Scott, 1894), a young male *coryphænæ*; *bicuspidatus* (Nordmann, 1832), a *curtus*; *carangis* (Kröyer, 1863), an *alalongæ*; *diaphanus* (Baird, 1850), a *curtus*; *elegans* (v. Beneden, 1851), a *curtus*; *elongatus* (Nordmann, 1832), a *rapax*; *leptochilus* (Leuckart, 1847), also a *rapax*; *longicaudus* (B-Smith, 1898, a), a *trichiuri*; *mulleri* (Leach, 1816), a *curtus*; *scomberi* (B-Smith, 1896), a *productus*; *rissonianus* (M-Edwards, 1840), a *curtus*; *scutatus* (M-Edwards, 1840), a *coryphænæ*.

Third, forms of which no figure has ever been published and which were so poorly described as to make their identification impossible. Here are included *affinis* (Heller, 1866), put into the key provisionally; *kroyerii* (M-Edwards, 1840), *piscinus*

(Guerin, 1817), *platessu* (v. Beneden, 1870), and the following which were simply named by Richiardi in 1880, *fissus*, *lepidopi*, *petersii*, *serrani*, *smaris*, and *trachuri*; and *lessonianus* (Risso, 1816).

Gayi is here included from a printed figure, the description not having been seen. And finally, the author has been unable to secure either the figures or descriptions of *heptapus* (Otto, 1821) or *hyalinus* (Czerniavski, 1868).

1. Carapace distinctly more than half the entire length.....2.
1. Carapace about half the entire length25.
1. Carapace decidedly less than half the entire length.....41.
 2. Abdomen four-jointed and shorter than genital segment; the latter quadrate.
alimicus, new species, p. 576.
 2. Abdomen two-jointed and longer than genital segment; all males.....3.
 2. Abdomen two-jointed, the same length as genital segment.....5.
 2. Abdomen two-jointed, shorter than genital segment.....11.
 2. Abdomen one-jointed, longer than genital segment.....12.
 2. Abdomen one-jointed, the same length as genital segment.....13.
 2. Abdomen one-jointed, shorter than genital segment.....17.
3. Abdomen joints about equal.....*bonito*, new species, p. 589.
3. Abdomen joints unequal, the first much the shorter.....4.
 4. Genital segment oblong, no wider than abdomen; fifth legs invisible dorsally.
stromatei (Kröyer, 1863).
 4. Genital segment quadrate, three-quarters wider than abdomen; fifth legs visible, large.....*rufinaculatus*, new species, p. 561.
 4. Genital segment barrel-shaped, one-third wider than abdomen; fifth legs visible, small.....*schistonyx*, new species, p. 564.
 5. Males, fifth legs plainly visible dorsally.....6.
 5. Males, fifth legs not visible dorsally.....7.
 5. Females, fifth legs not visible dorsally.....10.
6. Genital segment quadrate, half as wide as carapace; fourth legs large, all their spines serrate and a large plumose seta at the tip of the basal joint.
coryphanæ (Steenstrup and Lütken, 1861).
6. Genital segment quadrate, half as wide as carapace; fourth legs weak, no serrate spines, no setæ.....*thymni* (Dana, 1852) p. 603.
6. Genital segment oblong, one-quarter as wide as carapace; abdomen almost the same width, joints equal.....*diaphanus* (Nordmann, 1832).
7. Genital segment oblong, no wider than abdomen.....8.
7. Genital segment obovate or spindle-shaped, from one and a half to twice wider than the abdomen.....9.
8. First abdomen joint one-third the second; fourth legs short, just reaching the abdomen.....*irritans* (Heller, 1865).
8. Abdomen joints the same length; fourth legs reaching beyond tips of anal laminae.
longipes (B-Smith, 1898, c).
9. Free segment narrower than genital segment; frontal plates narrow, lunules small.....*gurnardi* (Kröyer, 1863).
9. Free segment same width as genital segment; frontal plates prominent, lunules large.....*rapax* (Milne-Edwards, 1840), p. 568.
9. Free segment wider than genital segment; third and fourth legs large and stout.....*mutabilis*, new species, p. 573.
10. Genital segment rectangular, wider than long; fourth legs very short; furca double.....*fallax* (Kröyer, 1863).
10. Genital segment obcordate, deeply lobed; fourth legs reaching beyond tip of abdomen.....*longipes* (B-Smith, 1898, c).
11. Males, genital segment subquadrate; fifth legs visible dorsally.
teres, new species, p. 649.

11. Males, genital segment elliptical; fifth legs not visible dorsally.
infestans (Heller, 1865).
12. Genital segment barrel-shaped, longer than wide, sides strongly curved; fifth legs large *minimus* (Otto, 1828).
12. Genital segment quadrate, much wider than long, emarginate posteriorly; fifth legs small..... *borealis* (Olsson, 1877).
13. Males, fifth legs plainly visible dorsally 14.
13. Females, fifth legs plainly visible dorsally 15.
13. Females, fifth legs not visible dorsally 16.
14. Genital segment semilunar, deeply lobed; free segment very short, almost concealed dorsally *centrodonti* (Baird, 1850), p. 652.
14. Genital segment acorn-shaped, deeply lobed; twice as wide as free segment; lobes acute..... *balistæ* (Steenstrup and Lutken, 1861), p. 601.
14. Genital segment oblong, no lobes; narrower than free segment; fourth legs very long..... *nanus* (Kröyer, 1863).
14. Genital segment obcordate, lobes short; three times as wide as free segment.
parrus (B-Smith, 1898, a).
15. Genital segment acorn-shaped, rounded posteriorly; furca long and narrow.
borealis (Olsson, 1877).
16. Genital segment oblong, widened posteriorly; abdomen much longer than wide.
dubius (T. Scott, 1894).
16. Genital segment quadrangular, corners square; abdomen the same length and width..... *gracilis* (Dana, 1852).
17. Abdomen more than half the length of genital segment 18.
17. Abdomen much less than half the genital segment 23.
18. Males, genital segment, but little wider than abdomen 19.
18. Females, both the fifth and sixth legs visible dorsally 20.
18. Females, only the fifth legs visible dorsally 21.
18. Females, neither fifth nor sixth legs visible dorsally 22.
19. Genital segment spindle-shaped; fourth legs with three saber-like spines.
labracis (T. Scott, 1902).
19. Genital segment orbicular, as wide as long; fourth legs with one toothed spine *curtus* (Müller, 1785), p. 578.
19. Genital segment cylindrical, sides parallel; fifth legs invisible dorsally.
cheilodactyli (Kröyer, 1863).
20. Genital segment triangular *isonyx* (Steenstrup and Lütken, 1861), p. 602.
21. Genital segment obcordate, lobes large; abdomen club-shaped, narrow.
minimus (Otto, 1828).
21. Genital segment rectangular, no lobes; abdomen as wide as long.
labracis (T. Scott, 1902).
21. Genital segment acorn-shaped, no lobes; abdomen spindle-shaped, longer than wide..... *lunpi* (Kröyer, 1863).
22. Genital segment oblong, no lobes; fourth legs only reaching its center.
curtus (Müller, 1785), p. 578.
22. Genital segment obcordate, as wide as long, with short lobes; fourth legs reaching abdomen..... *gurnardi* (Kröyer, 1863).
22. Genital segment barrel-shaped, wider than long; lobes short; toothed plates on fourth-leg spines *teres*, new species, p. 649.
22. Genital segment ovate, no lobes; whole body covered with spots of rust color.
rufimaculatus, new species, p. 561.
22. Genital segment barrel-shaped, wider than long; no lobes; abdomen narrow; body highly colored *gayi* (Nicolet, 1849).
22. Genital segment elliptical, lobes short; terminal claws on first legs bipartite.
schistonyx, new species, p. 564.

23. Fifth legs visible dorsally; males or females; genital segment subquadrate.
abbreviatus (Kröyer, 1863).
23. Fifth legs invisible dorsally, all females.....24.
24. Genital segment rectangular, much longer than wide, no lobes; sides nearly parallel.....*brevicaudatus* (A. Scott, 1901).
24. Genital segment rectangular, much wider than long, no lobes; sides nearly parallel.....*parrus* (B-Smith, 1898, a).
24. Genital segment obovate, as wide as long, sides strongly curved; small plates on free segment.....*centrodonti* (Baird, 1850), p. 652.
24. Genital segment obovate, deeply lobed; lobes acute, conical; free segment narrow and long.....*balistæ* (Steenstrup and Lütken, 1861), p. 601.
25. Abdomen three-jointed; genital segment flask-shaped, truncate posteriorly.
angustatus (Kröyer, 1863).
25. Abdomen two-jointed, of varying lengths.....26.
25. Abdomen one-jointed, of varying lengths.....34.
26. Abdomen longer than the genital segment, males or females.....27.
26. Abdomen about the same length as the genital segment.....28.
26. Abdomen half as long as the genital segment or more.....31.
27. Males, genital segment quadrangular; free segment as wide as long.
hirsutus (B-Smith, 1898, a).
27. Males, genital segment narrow spindle-shaped; free segment four times as wide as long.....*bonito*, new species, p. 589.
27. Females, genital segment acorn-shaped; free segment twice and a half as wide as long.....*chelifæ*, new species, p. 582.
28. Males, fifth legs visible dorsally; genital segment acorn-shaped; first abdomen joint smaller.....*robustus* (B-Smith, 1898, b).
28. Males, fifth legs invisible dorsally.....29.
28. Females, fifth legs plainly visible.....30.
28. Females, fifth legs invisible dorsally; genital segment oblong; basal abdomen joint the longer.....*cybii* (B-Smith, 1898, a).
29. Genital segment barrel-shaped, only a little longer than wide, corners angular.....*thymni* (Dana, 1852), p. 603.
29. Genital segment narrow, club-shaped, twice as long as wide, corners rounded.
trichiuri (Kröyer, 1863).
30. Genital segment obcordate; basal abdomen joint four times the terminal.
robustus (B-Smith, 1898, b).
30. Genital segment oblong, widest posteriorly; terminal abdomen joint much the longer.....*thymni* (Dana, 1852), p. 603.
31. Males, fifth legs not visible dorsally.....32.
31. Females, fifth legs not visible dorsally.....33.
32. Genital segment orbicular, half as wide as carapace; basal abdomen joint short and wide.....*infestans* (Heller, 1865).
32. Genital segment elliptical, one-third as wide as carapace; basal abdomen joint quadrangular.....*hamulonis* (Kröyer, 1863), p. 606.
33. Genital segment oblong, narrowed anteriorly; deeply emarginate posteriorly; lobes long.....*infestans* (Heller, 1865).
33. Genital segment flask-shaped; slightly emarginate posteriorly; lobes short and broad.....*belones* (Kröyer, 1863), p. 586.
33. Genital segment orbicular, as long as wide, evenly rounded; basal abdomen joint longer.....*revator* (Heller, 1865).
34. Abdomen obconical, longer than the genital segment; the latter flask-shaped; males.....*phipsoni* (B-Smith, 1898, a).
34. Abdomen same length as genital segment; the latter oblong; fourth legs short and weak; females.....*dubius* (T. Scott, 1894).

34. Abdomen half the length of the genital segment or more35.
34. Abdomen distinctly less than half the genital segment.....40.
35. Males, genital segment narrow cylindrical, no wider than abdomen; fifth legs invisible.....*chorinemi* (Kröyer, 1863).
35. Females, fifth legs plainly visible dorsally36.
35. Females, fifth legs not visible dorsally.....37.
36. Genital segment elongate-ovate; fifth legs close to the base of the abdomen.
gurnardi, var. (Kröyer, 1863).
36. Genital segment broad acorn-shaped; fifth legs at corners; fourth legs reaching abdomen center.....*nanus* (Kröyer, 1863).
36. Genital segment acorn-shaped, fourth legs not reaching its center; fifth legs at corners.....*lumpi* (Kröyer, 1863).
37. Genital segment distinctly more than half the carapace.....38.
37. Genital segment half as long as carapace or less39.
38. Genital segment oblong; abdomen club-shaped; free segment much longer than wide.....*phipsoni* (B-Smith, 1898, a).
38. Genital segment orbicular, wider than long; frontal plates projecting between the lunules.....*hemulonis* (Kröyer, 1863), p. 606.
38. Genital segment obcordate, the same length and width; free segment wider than long.....*trachipteri* (Kröyer, 1863).
39. Genital segment obovate, sides strongly curved; carapace wider than long.
cheilodactyli (Kröyer, 1863).
39. Genital segment acorn-shaped, sides parallel; carapace elliptical; first antennæ hidden.....*lucustris* (Steenstrup and Lütken, 1861).
39. Genital segment acorn-shaped; carapace elliptical; first antennæ large, prominent.....*rapax* (Milne-Edwards, 1840), p. 568.
39. Genital segment quadrate; frontal plates wide, lunules large; carapace ovate.....*latifrons*, new species, p. 587.
40. Genital segment obcordate, posterior lobes large; fourth legs large, stout; fifth legs visible.....*minimus* (Otto, 1828).
40. Genital segment flask-shaped, no lobes, fourth legs short, weak; fifth legs invisible.....*atalongæ* (Kröyer, 1863).
40. Genital segment rectangular, much wider than long, no lobes; abdomen extremely short.....*parrus* (B-Smith, 1898, a).
41. Abdomen four-jointed; genital segment wedge-shaped and deeply lobed.
coryphæus (Steenstrup and Lütken, 1861).
41. Abdomen two-jointed, of varying lengths42.
41. Abdomen one-jointed, of varying lengths54.
42. Abdomen distinctly longer than the genital segment.....43.
42. Abdomen about the same length as the genital segment47.
42. Abdomen considerably shorter than the genital segment.....53.
43. Males, fifth legs concealed in a dorsal view.....44.
43. Females, fifth legs plainly visible dorsally.....45.
43. Females, fifth legs concealed in dorsal view.....46.
44. Genital segment quadrate; first abdomen segment less than half the second.
hirsutus (B-Smith, 1898, a).
44. Genital segment narrow ovate; first abdomen joint twice as long as the second.
trichiuri (Kröyer, 1863).
45. Genital segment broad ovate; fifth and sixth legs both showing in dorsal view.....*pelamydus* (Kröyer, 1863), p. 594.
45. Genital segment acorn-shaped; fifth legs only showing and indistinctly; abdomen twice as long as all the rest of the body.....*macrurus* (Heller, 1865).
45. Genital segment rectangular, much wider than long; fifth legs only showing.....*trichiuri* (Kröyer, 1863).

46. Genital segment triangular, much larger than carapace; abdomen longer than rest of body *pharaonis* (Nordmann, 1832).
46. Genital segment acorn-shaped; basal abdomen joint three times the terminal.
..... *pelamydis* (Kröyer, 1863), p. 594.
47. Males, fifth legs not visible in dorsal view 48.
47. Females, fifth legs plainly visible in dorsal view 49.
47. Females, fifth legs concealed in dorsal view 50.
48. Genital segment cylindrical, little wider than abdomen; median carapace lobe projecting its full length behind the lateral lobes. *cossacki* (B-Smith, 1898, b).
48. Genital segment obovate, twice as wide as abdomen; median carapace lobe not projecting at all *constrictus* (Heller, 1865).
48. Genital segment barrel-shaped, three times as wide as abdomen; first abdomen joint the longer *affinis* (Heller, 1866).
48. Genital segment oblong-obovate, twice as wide as abdomen; terminal abdomen joint the longer *productus* (Dana, 1852), p. 597.
49. Genital segment flask-shaped, no lobes; abdomen narrow; joints the same width *diaphanus* (Nordmann, 1832).
49. Genital segment obcordate, deeply lobed; basal abdomen joint twice as wide as terminal *robustus* (B-Smith, 1898, b).
50. Abdomen joints about equal in length 51.
50. Abdomen joints very unequal in length 52.
51. Genital segment acorn-shaped, longer than wide; fourth legs weak, three-jointed.
..... *cossacki* (B-Smith, 1898, b).
51. Genital segment orbicular, wider than long; fourth legs medium-sized, four-jointed *torpedinis* (Heller, 1865).
52. Genital segment oblong, deeply lobed; basal abdomen joint ten times the terminal *arii* (B-Smith, 1898, b).
52. Genital segment oblong, slightly lobed; basal abdomen joint three times the terminal *cybii* (B-Smith, 1898, a).
52. Genital segment elliptical, lobes long and very wide; basal abdomen joint three times the terminal *bonito*, new species, p. 589.
52. Genital segment flask-shaped, no lobes; basal abdomen joint twice the terminal *affinis* (Heller, 1866).
53. Genital segment elongate-obovate, contracted anteriorly; fifth legs invisible; abdomen joints equal *mutabilis*, new species, p. 573.
53. Genital segment broad, acorn-shaped; fifth legs visible; basal abdomen joint three times the terminal *chorinemi* (Kröyer, 1863).
53. Genital segment obovate, lobes short; basal abdomen joint four times the terminal *irritans* (Heller, 1865).
54. Abdomen distinctly longer than the genital segment 55.
54. Abdomen about the same length as the genital segment 56.
54. Abdomen considerably shorter than the genital segment 57.
55. Genital segment orbicular, showing both the fifth and sixth legs, female.
..... *stromatei* (Kröyer, 1863).
55. Genital segment triangular; only the fifth legs showing; fourth leg spines flattened into laminae *platytarsi* (B-Smith, 1898, b).
55. Genital segment obcordate, little wider than abdomen; fifth legs concealed.
..... *hirsutus* (B-Smith, 1898, a).
55. Genital segment elliptical, three times as wide as abdomen; fifth legs concealed.
..... *productus* (Dana, 1852), p. 597.
56. Genital segment elliptical, lobes long and narrow; free segment long and wide.
..... *monacanthi* (Kröyer, 1863) 607.
56. Genital segment oblong-obovate; lobes short and broad; free segment short, narrow *productus* (Dana, 1852), p. 597.

56. Genital segment rectangular; no lobes; free segment short and wide.
dakari (van Beneden, 1892).
57. Females, both fifth and sixth legs visible; genital segment acorn-shaped.
isonyx (Steenstrup and Lütken, 1861), p. 602.
57. Females, no legs visible on genital segment 58.
57. Males, fifth legs concealed; genital segment narrow ovate, well lobed; emarginate
 posteriorly *chorinemi* (Kröyer, 1863).
58. Genital segment oblong, four times as wide as abdomen; no lobes; frontal
 plates projecting *murrayanus* (T. Scott, 1894).
58. Genital segment elliptical, twice as wide as abdomen; no lobes; free segment
 long, narrow *trachynoti* (Heller, 1865).
58. Genital segment narrow obovate, well lobed; free segment short and broad.
tenax (Heller, 1865).
58. Genital segment oblong; lobes short, blunt; abdomen club-shaped; free seg-
 ment long, narrow *phipsoni* (B-Smith, 1898, a).

CALIGUS RUFIMACULATUS, new species.

Plate V.

Female.—Carapace more than half the entire length, elliptical, distinctly longer than wide, and scarcely narrowed anteriorly (fig. 51).

Frontal plates large and wide, nearly straight along their anterior border, and deeply incised at the center, where may nearly always be found the remains of the frontal filament projecting from the incision. Lunules large, almost circular, and widely separated, but not projecting very much. Posterior sinuses wide and inclined to the central axis, leaving the median lobe more than half the entire width and projecting considerably beyond the lateral lobes. Lateral lobes narrow and curved inward at the tip. Free thorax segment small and narrow, not distinctly separated from the genital segment, the dividing groove being little more than a notch in either side, just back of the fourth legs. Genital segment obovate, as wide as long, narrowed anteriorly, with smooth, rounded outlines, and without appendages or setae visible dorsally.

Abdomen short and one-jointed, three-fourths the length of the genital segment and about twice as long as wide; somewhat swollen at the center into a spindle-shape. Anal laminae large and stout. Egg cases nearly as wide as the abdomen and about as long as the carapace, 35 or 40 eggs in each.

Anterior antennae large and stout, the two joints about the same length and heavily armed with plumose setae and spines. Posterior antennae rather slender, but long, and with the terminal hook sharply bent near the tip; a short and stout accessory spine present posterior to the basal joint. First maxillae small and nearly straight, with a swollen base. Second maxillae also nearly straight and about as long as the rostrum; rather stout and blunt and considerably widened at the base.

First maxillipeds with a rather stout basal joint and the usual slender terminal joint, the two joints in this species being about the same length. The two terminal claws are fringed with hairs and look more like plumose setae than like claws, and there is also a small protuberance on the inner margin near the tip which carries a tuft of hairs. The second maxillipeds have a stout basal joint, but a very weak terminal claw, the tip of which is abruptly narrowed at the junction of the accessory spine on the inner margin. Furca peculiar; branches about the same length at the base, both increasing in width from the center, giving the whole structure somewhat the outline of an hourglass. Branches flattened dorso-ventrally, as wide at the tip as at the base, and considerably divergent; lumen broad, triangular. First legs with three weak terminal claws, a long and slender plumose seta at the posterior corner, and the usual three plumose setae along the posterior border of the terminal joint. Second and third legs large and stout; the spine on the last joint of the exopod of the second legs is noticeably slender and weak, while that upon the basal joint of the exopod of the third legs is stout and as wide at the tip as at the base. Rami of the third legs well separated, large and prominent. Fourth legs small and weak, not reaching the posterior margin of the genital segment; three-jointed with five spines, the terminal ones graded in length from without inward, the inner one three times as long as the outer. Fifth legs very rudimentary, scarcely visible in ventral view.

Male.—Carapace the same shape as in the female, but relatively much larger. Free thoracic segment much more distinctly separated from the genital segment and nearly as wide as the latter (fig. 52).

Genital segment very much smaller than in the female, being only a quarter the length of the carapace; fifth legs showing plainly on the lateral margins about one-third the distance from the posterior end. Abdomen little more than half the width of the genital segment and about one-fifth longer; two-jointed, the basal joint less than half the length of the terminal. Anal laminae much larger than those of the female and armed with longer setae. The chief differences in the appendages are found in the second antennae, the first maxillae, the second maxillipeds, the furca, and the third and fourth swimming legs.

The second antennae are larger and stouter than those of the female and are branched as is usual in the males of this genus.

The first maxillae are fully twice as long as in the female, and are strongly curved, evidently serving as secondary clasping organs. The second maxillipeds are much enlarged in both the basal and terminal joints. In the center of the basal joint on the inner margin, opposite the base of the accessory spine, there is a large swelling capped by a small hemispherical plate with a roughened surface. This aids in the prevention of slipping, and shows that these maxillipeds with the second antennae are manifestly the chief organs of prehension (fig. 57).

Furca much narrower than in the female, branches close together and nearly parallel, destroying the hourglass outline.

Third legs larger than in the female, attached nearer the posterior border of the carapace, and projecting laterally to the edge of the carapace, and posteriorly to the center of the genital segment. The basal joint of each is fully as large as the genital segment, and being transparent the longitudinal fibers of the muscles show through plainly and give the central portion a striated appearance. The fourth legs are relatively much longer than those of the female.

Total length, female 3.63 mm.; male 3 mm. Length of carapace, female 2 mm.; male 1.9 mm. Length of genital segment, female 0.84 mm.; male 0.5 mm. Length of abdomen, female 0.65 mm.; male 0.6 mm. Length of egg strings 1.9 mm.

Chalimus.—Carapace considerably more than half the entire length, ovate, strongly narrowed anteriorly. Frontal plates large and well defined. Posterior sinuses narrow and nearly parallel, the median lobe proportionally a little wider and more squarely truncated posteriorly than in the adult (fig. 53).

First antennæ large, prominent, and well armed with plumose setæ and spines. Free segment very short, but as wide as the genital segment. The latter is barrel-shaped, one-quarter wider than long with evenly rounded sides and squarely truncated anterior and posterior borders.

The two abdomen segments are about the same relative size as in the adult, but compared with the genital segment they are much wider, in fact almost as wide as the genital segment itself.

The anal laminae are smaller than in the adult and their plumose setæ are shorter. The appendages appear about the same with the exception that the second, as well as the third swimming legs show posterior to the carapace in dorsal view. Total length 1.75 mm. Length of carapace 1 mm.; width of the same 0.8 mm. Length of genital segment 0.3 mm. Length of abdomen 0.4 mm.

Color, pale straw yellow, covered on both the dorsal and ventral surfaces with scattered spots of a rusty brown pigment. In some specimens these spots are few in number and not noticeable, but in the great majority of instances they are quite numerous and at once catch the eye, particularly on the dorsal surface of the genital segment.

(*rufus*, rust color; *maculatus*, spotted.)

Specimens belonging to this species were obtained by the author from *Fundulus majalis* and *F. heteroclitus*.

They are more often found upon the former but are not at all common, a careful examination of five hundred of these minnows yielding barely half a dozen specimens. The National Museum collection also includes three specimens taken by Vinal N. Edwards, one from a mullet (*Mugil cephalus*), and the other two from the surface at the Fish

Commission, Woods Hole. The fact that these two were captured in surface skimmings is an indication that this species swims about freely at the breeding season.

As the measurements indicate they are very small and well suited to parasitism upon such small fish. They are also very transparent and might well have been named *diaphanus* had not that name already been preoccupied. Consequently it makes an excellent species for study, since the internal anatomy can be plainly seen without dissection, and the small size is to its advantage when examined under a high power. It is a very lively species and moves about freely over the body of its host. Like the *Argulus* found upon the same minnows, this species occasionally forfeits its life when the fish get hungry, and the author lost a fine lot of males and females which were being kept upon *Fundulus* in an aquarium, the fish catching them as they were swimming about.

CALIGUS SCHISTONYX, new species.

Plate VI.

Female.—Carapace one-sixth longer than the rest of the body, about as wide as long, ovate, strongly narrowed anteriorly. Frontal plates wide and prominent; lunules large, almost circular, slightly projecting. Posterior sinuses rather narrow and somewhat inclined to the median axis; median lobe less than half the entire width and projecting but little beyond the lateral lobes; the latter broad and well rounded (fig. 66).

The carapace is very peculiar in its grooving; the thoracic area is almost quadrilateral and is about three-fifths of the length and width of the carapace. From each of its anterior corners a pair of parallel grooves extend diagonally forward and outward to the very edge of the carapace. These grooves are close together and each makes a break in the continuity of the carapace margin. This is the only instance within the author's experience, in which any of the carapace grooves actually reach the margin, and it is very noticeable for that reason.

Taken in connection with the groove along the anterior border of the thoracic area it forms a joint extending the entire width of the carapace and separates the head as completely from the thorax as the latter is separated posteriorly from the abdomen.

The central portion of the thoracic area is raised considerably, leaving a very narrow depressed border around the posterior margin. The line of demarcation between the raised and depressed portions is not parallel with the carapace margin, but on either side forms a straight line inclined toward the central axis and in direct continuation of the posterior of the two inclined grooves already noted. The combination of this line of demarcation and the grooves thus produces a

trapezium or wedge which stands out very prominently upon the dorsal surface of the carapace. Furthermore, the transparent border surrounding the carapace, instead of being more broadly rounded than the lateral lobe at the posterior extremity of the latter, the condition which prevails in all other species, comes to a sharp point, giving the carapace a peculiar angular appearance.

The free thoracic segment is very short and narrow, about three-fifths as wide as the genital segment. Genital segment oblong, with well-rounded corners, half as wide as the carapace, with short and blunt posterior lobes between which the posterior margin is concave. Abdomen four-fifths as long as the genital segment and somewhat less than half as wide; sharply contracted where it joins the genital segment and slightly swollen at the center. Anal papillæ large, well separated, and somewhat curved inward at the tips, bearing plumose setæ which are very long and slender. Egg cases three-quarters as wide as the abdomen and a little longer than the carapace; about 60 eggs in each. Anterior antennæ short and stout, the basal joint very plentifully supplied with plumose setæ along its anterior and lateral margins; terminal joint club-shaped.

Second antennæ with a stout basal joint reinforced by a short, blunt spine posteriorly; terminal joint long and slender, with an abrupt curve. First maxillæ short, blunt, almost straight, and considerably swollen at the base.

Second maxillæ simple, unbranched, nearly as long as the rostrum, slightly curved if at all, and acuminate.

First maxillipeds with a stout basal joint and a long slender terminal joint; the inner terminal claw twice the length of the outer; a short spur on the inner margin of this joint near the distal end. Second maxillipeds with a stout and swollen basal joint and a very weak and slender terminal claw, the disproportion between the two being quite noticeable.

The claw is only half the length and not more than one-fifth the width of the basal joint, and its terminal portion beyond the base of the accessory spine is scarcely larger than the spine itself. The inner margin of the basal joint is raised into a slight knob opposite the base of the accessory spine, but the flimsy little terminal claw does not look as though it could hold down very much against this knob. Furca long and narrow, with branches about the same length and width as the basal portion; considerably narrowed at the center, like an hour-glass. The divergent branches curve inward toward each other, while the sides of the base curve outward away from each other, but only slightly in either case. Often the branches are somewhat swollen at the tips.

The first legs are short and stout, with two spines on the posterior border of the basal joint and a single small spine at the distal end of

the second joint, at the anterior corner. The terminal claws on these legs are peculiar in that they are all three biramose, the division extending well beyond the middle of the claw. Of the two branches the endopod is nearly straight, while the exopod is strongly curved. Furthermore, the appendage at the inner corner, between the terminal claws and the posterior plumose setæ, instead of being a smaller plumose seta, as is usually the case, is here a long and stout claw, unbranched and curved over strongly ventrally (fig. 75).

This peculiarity of the terminal claws has given the species its name. The other legs are like those ordinarily found on *Caligus*. The spines upon the last two joints of the exopod of the second legs are very small and insignificant, while that upon the basal joint of the exopod of the third legs is large and stout. The rami of these third legs are widely separated and the endopod has but a single joint.

The fourth legs are very slender and weak, three-jointed, with the basal joint as long as the other two. The second joint has a spine at its distal end and another small one on its outer margin. The terminal joint has the usual three terminal spines, of which the inner one is fully twice as long as the second, and a small spine on its outer margin.

The fifth legs are so far reduced as to be invisible except by very careful scrutiny upon the ventral surface.

Male.—The sides of the carapace are not arched as in the female but are nearly straight lines, and the anterior contraction is much more decided. The posterior sinuses are a very broad U-shape, throwing the tips of the lateral lobes outward away from the median lobe. This, together with the sharp angles of the transparent border, gives the carapace a marked trapezoidal form, the anterior and posterior sides parallel, the former only two-fifths the length of the latter, while the right and left sides are equally inclined. The trapezoid formed upon the dorsal surface by the grooves between the different areas is the exact reverse of this formed by the margin, and is not as clearly defined as in the female. The thoracic area is more nearly semicircular in outline than quadrilateral (fig. 65).

The large basal joints of the third legs project from either side of the median carapace lobe and do not overlap the lateral lobes, nor even reach them. The genital segment is very small, scarcely wider than the abdomen, as wide as long, with evenly rounded sides. The fifth legs appear as very small papillæ upon the lateral margins near the posterior end of the segment. The abdomen is two-jointed, the joints of the same diameter but the terminal one four times the length of the basal.

Anal papillæ very large and foliaceous, with long and slender plumose setæ.

The only appendages which are at all worthy of special mention are

the second antennæ and the second maxillipeds. The second antennæ are very much enlarged and three-jointed. The two basal joints are stout and swollen, while the terminal joint is considerably smaller and terminates in a short, stubby claw. The ventral surface of the second joint is parted for a little distance from the distal end by a deep groove, which, starting at about the center of the distal margin, curves around inward in a broad sweep and disappears quickly upon the ventral surface. Along either side of this groove the chitin integument is raised in transverse folds whose anterior edge overlaps the posterior one of the fold next in front, thus giving a rasp-like surface which must be of great assistance in the prevention of slipping. The line of folds along the inside of the groove extends backward, following the sweep of the groove, across the ventral surface to the proximal end of the joint. The folds along the outer side of the groove stop with the groove itself. The terminal joint is exceptionally peculiar. It is about as wide as long and consists essentially of a very stout claw which is blunt and strongly curved at the tip. But upon the ventral surface of this claw near the posterior margin are two stout accessory spines, each arising from a raised base. And in the center of the basal portion of the claw is a circular, raised area with its surface thrown into longitudinal ridges or folds, which project considerably. This, like the rasp-surface on the second joint, must assist in obtaining a firm hold, and are the more needed in the male since these antennæ are used for clasping organs.

The second maxillipeds are much larger than those of the female but otherwise like them, and they evidently serve as accessory clasping organs.

Total length of female 4 mm.; length of carapace 2.1 mm.; width 2.1 mm.; length of genital segment 1 mm.; length of the abdomen 0.8 mm.; length of egg-strings 3.5 mm. Total length of male 3 mm.; length of carapace 1.75 mm.; width 1.66 mm.; length of genital segment 0.4 mm.; length of abdomen 0.62 mm.

Color a dark yellow, inclining toward brown in many specimens. (*schistomys*, $\sigma\chi\iota\zeta\omega$ to cut or divide, and *ovvξ* a claw.)

The National Museum collection includes five lots from the common menhaden (*Brevoortia tyrannus*), numbered 6052, 6060, 6071, 6150, 6157. Of these, the first three contain but a single female each, while the last two contain thirteen specimens, two of which are males. They were all obtained from the outside of the body. There is a single female, numbered 6151, from the outside surface of the blue-fish (*Pomatomus saltatrix*), and nine lots obtained from the tow. Of these latter, eight are numbered 6038, 6070, 6095, 6098, 6099, 6100, 6101, 8111, while the ninth is without a number. The first of these lots contains four males, the other eight lots are made up of a single specimen each and evenly divided between the sexes.

This distribution shows two facts very plainly. First, the menhaden is evidently the host of the species, the presence of a single specimen on the blue-fish being easily explained by the fact that the latter feeds upon the menhaden. And then such a large percentage taken in the tow indicates that this species is very active, as much so as *U. rapax*, although its hosts are nowhere near as numerous as those of the latter species.

There is also a strong suggestion that these parasites are not likely to change their depth very materially; those which frequent surface fish stick to the surface even when they are swimming about freely. And probably the same can be said of those which are parasitic on fish that frequent the bottom.

This species is not very abundant, as the paucity of specimens clearly shows. As they were all taken in the latter part of August and the first of September, this period is probably the height of the breeding season.

The species can be recognized easily by the sharp angles at the posterior corners of the carapace and the general trapezoidal appearance of the latter. The diagnosis can then be verified by an examination of the claws at the tips of the first swimming legs.

CALIGUS RAPAX Milne Edwards.

Plate VII, figs. 3, 7, 9, 10, 18, 22, 23, 26, 32, 36, 46, 47, 48, 49, 50 in the text.

Caligus elongatus NORDMANN, 1832, p. 24.

Caligus elongatus KRÖYER, 1837, p. 201.

Caligus rapax MILNE EDWARDS, 1840, p. 453, pl. XXXVIII, figs. 9-12.

Caligus elongatus MILNE EDWARDS, 1840, p. 454.

Caligus leptochilus FREY and LEUCKART, 1847, p. 165.

Caligus rapax BAIRD, 1850, p. 270, pl. XXXII, figs. 2 and 3.—WHITE, 1850, p. 119.—STEENSTRUP and LÜTKEN, 1861, p. 359, pl. II, fig. 4.—KRÖYER, 1863, p. 71.—OLSSON, 1868, p. 8.—MACINTOSH, 1874, p. 262.—SMITH, 1874, p. 575.—RICHIARDI, 1880, p. 148.—BASSETT-SMITH, 1896, p. 156; 1899, p. 448.—BRIAN, 1898, p. 10, pl. II, fig. 6; 1899, p. 2.—T. SCOTT, 1900, p. 148, pl. v, figs. 13-19.

Female.—Frontal plates wide; frontal margin slightly rounded; lunules large, orbicular, and projecting considerably. Carapace ovate, longer than wide; posterior sinuses narrow, of medium depth, and with approximately parallel sides; thoracic area broad, three-fifths of the entire width, well rounded, and projecting posteriorly about the depth of the sinuses beyond the lobes; lobes narrow, short, slightly wider at the tips (fig. 79).

Free thorax segment very short, only three-tenths as wide as the carapace. Genital segment large, more or less quadrilateral, with rounded corners, slightly wider than long, seven-tenths the width of the carapace. Abdomen unsegmented, varying considerably in length (from 0.5 to 0.8 the length of the genital segment), about half as wide as the genital segment; anal sinus scarcely perceptible; anal laminae of

good size, terminated by one short and three long plumose setæ, the longest about three times the length of the laminae.

First antennæ large, their tips nearly equaling the extreme width of the carapace; terminal segment about the same length as the basal, one-quarter as wide as long.

Second antennæ close together and rather weak, with a small supplementary hook on the posterior margin of the basal joint. Mouth with a somewhat quadrilateral opening fringed by long setæ; margin of the upper lip incised at the center; mandibles stout, strongly curved, and toothed along their inner border.

First maxillæ small, short, and slightly curved; second maxillæ slender, nearly straight, and acuminate.

First maxillipeds with a very slender terminal joint about half as long again as the basal joint, the two curved claws at the tip very unequal. Second maxillipeds fairly stout, the basal joint and the terminal claw of about the same length, the latter with a small curved spine on its inner margin.

Of the swimming legs the first pair is three-jointed; the basal joint is swollen and armed with two spines on its outer margin, and a chitin plate carrying a spine on its posterior margin.

The plate is transversely elongated and has a large blunt projection near its distal end.

The fourth swimming legs are three-jointed; the triangular second joint terminates externally in a long spine; the terminal joint has a stout spine on its external margin, and three long and one short (the inner) spine at the tip.

Total length 5-7 mm. Length of carapace 2.6-3.6 mm.; length of genital segment 1.5-2.2 mm.; width of carapace 2.4-3.4 mm.; length of abdomen 1-1.5 mm.; length of egg-strings 2.6-3 mm.

Male.—Carapace about as broad as long and relatively wider anteriorly than in the female; the posterior sinuses are also much wider and their sides are flaring instead of parallel. The thoracic area is only one-third the width of the carapace, and it scarcely projects posteriorly at all; the lobes are much wider than those of the female and are well rounded. The free thoracic segment is considerably longer and narrower than in the female, while the genital segment is pear-shaped, only one-third the width of the carapace and well rounded posteriorly. The abdomen is about the same length as the genital segment, two-jointed, with the first joint one-third as long as the second (fig. 80).

The anal laminae are long and large, and are attached to the outer posterior corners of the abdomen; the plumose setæ are fully twice as long as in the female.

On the ventral surface the second antennæ and second maxillipeds are stouter than in the female, and the small spine on the side of the

latter is much larger. In the fourth swimming legs the terminal joint is longer, and the spines and setae differ slightly in their relative length and arrangement. In both the male and female the bases of these spines are reinforced by semicircular plates fringed with small hairs.

Total length 4-5 mm. Length of carapace 2.35 mm; width of same 2 mm.; length of genital segment 0.75 mm.; length of abdomen 1 mm.

Nauplius larva.—Body elliptical, widest at about the center; width to the length as 3 to 5. Appendages projecting far beyond the body margin and typical in form (fig. 36, p. 536).

First antennae uniramous, terminating in two plumose setae; second antennae and mandibles biramous; exopod four-jointed, endopod two-jointed; each joint of exopod bearing a long plumose seta, while the terminal joint of the endopod carries two setae.

The median eye is placed very far forward and concealed beneath a spot of pigment. The anal setae are flattened spoon-shaped, of good length, and they project sidewise from the body instead of diagonally backward. The color is a pale yellowish, with rust-colored pigment distributed in five spots, a small area over the median eye anteriorly, a large area on either side at the center, and a small area on either side just in front of the anal setae or balancers. The pigment is comparatively faint and scarcely appears under a low power as it does in other species. The anterior half of the body is very transparent and shows the internal structure plainly. Total length, 0.4 mm. Width, 0.23 mm.

Chalimus stage.—Carapace elongate-ovate or spindle shape, narrower anteriorly; frontal plates narrow and inclined backward along the front margin of the carapace. Posterior lobes small, turned inward strongly, and with scarcely any sinus; posterior margin of carapace squarely truncate. Eyes a little behind the center of the carapace, large and prominent; frontal gland very large and occupying the whole of the anterior angle of the carapace. Free segment much larger than in the adult, one-third the length, and more than half the width of the carapace, its sides strongly convex. Genital segment and abdomen at first fused and about the same width as the free segment, but separating with the first moult, the abdomen several times the larger. Anal laminae short and wide, and projecting diagonally sidewise rather than straight backward; the plumose setae very short and stout. Both pairs of antennae and all the mouth parts present but somewhat rudimentary, especially the second antennae, whose terminal joint is little more than a small spine on the tip of the large basal joint (figs. 46-50).

The first two pairs of swimming legs are the only ones developed in early chalimus stages, and they are worthy of notice from the fact that the first pair is biramous; but the endopod is made up of a single joint, which is very small and quickly disappears. Color the same as

that of the adult, except that the pigment spots are much fewer in number and more widely separated. Length 2 mm., increasing gradually to 3.5 or 4 mm. Width of carapace 1 mm., increasing to 2 mm. Width of free segment 0.55 mm., length 0.55 mm. Length of abdomen 0.8 mm.

(*rapax*, rapacious, greedy.)

This is the most common species of the genus on the northeastern coast of the United States, having been taken from more than twenty-five different kinds of fish by many collectors working in the interests of the United States Fish Commission.

The author, following the example of Mr. Richard Rathbun, as expressed in some very valuable manuscript notes, the substance of which is here presented, has been liberal in his interpretation of specific characters. In consequence, there are included under this species individuals which some investigators would probably subdivide into several lots. But after a very careful comparison the differences observed are really too obscure to be of much value for classification. The variation does not extend far in any one direction, and there is comparatively little difference in size. The detail of the appendages agrees very closely in all the specimens, and careful comparisons have been made in every instance with authentic specimens from Europe. Specimens from the mackerel present perhaps the most marked differences in structure, but they vary among themselves and many are perfectly normal. These differences concern chiefly the fourth pair of legs. Sometimes the second of the terminal spines, counting from the proximal end of the terminal joint, is wanting. Again, the ultimate and penultimate joints are relatively shorter and stouter than in normal specimens; or the three successive spines on the outer margin may overlap one another; or the fringed disks at the bases of these spines may be so little developed as to be overlooked. In specimens from other fish the furca may have shorter and stouter branches, while on the common flounder individuals may be found with the abdomen so much shortened as to appear like those of *C. curtus*. But in all these instances the other appendages are perfectly normal, and it does not seem as if these differences were worthy of creating even a well-marked variety, to say nothing of a distinct species.

They must be mentioned, however, to show that they have been noted and given the proper attention.

Both sexes are usually found upon the same fish and occur anywhere upon the external surface, often showing a preference for the pectoral fins. Upon the flounders and skates they are commonly on the upper or pigmented surface, but also occur on the unpigmented ventral surface. Here again, as in the case of the Arguli, when we reflect that these fish frequent the bottom, and that they often bury themselves in the sand or mud, we can appreciate better the effectiveness of a

prehensile apparatus which holds the Caligus securely to its host, even in the presence of so much friction.

Of course the color of the Caligus harmonizes better with the pigmented side of the fish; on the under surface the copepod stands out in strong contrast with its surroundings.

The egg strings in this species are comparatively short, and this gives the female greater freedom of motion. Both males and females are more lively than most species, and they manifest this activity frequently by leaving their host and swimming about freely. This happens more often at night than during the daytime, and several investigators have recorded the capture of both sexes in the tow along with free forms.

Such a habit possibly helps in explaining their presence upon so many different kinds of fish. Many of the latter, no doubt, are mere temporary makeshifts to tide over a necessary interval and to keep the copepod supplied with food until it can return to its regular host.

Associated with its distribution among so many hosts is a considerable variation in the color pattern. Most specimens have a pale orange tint and are more or less transparent, but it can be readily seen that those obtained from dark fish or from the darker pigmented surface are themselves of a deeper color and more opaque than others from light fish or from a nonpigmented surface. The difference is due to an increase or decrease in the number of pigment spots and not to any fundamental change in the pigment itself. Each spot consists of an uniformly colored center as if washed in with water color, and long irregularly radiating filaments. The spots are thickest along the margin of the carapace where the filaments are interwoven into a dense, narrow band, close to the margin. Similar but much wider bands are found along the sides of the genital segment and the abdomen. There is also a spot of pigment just dorsal to the furca, and another upon either side on the basal lamina of the third pair of legs, showing dorsally between the carapace and abdomen. The frontal plates, the region over the eyes, the whole of the thorax, including the segments fused with the head, and the center of the genital segment and abdomen are ordinarily free from pigment.

This species has been secured from the following fish on the North American coast, mostly by the United States Bureau of Fisheries. The numbers are those given to the separate lots in the National Museum. From the common flounder (*Pseudopleuronectes americanus*), lots 1267 and W. 18; from the four-spotted flounder (*Paralichthys oblongus*), lot 12607; from the cod (*Gadus morhua*), lots 8112, 8115, 12635, 12636, 12638, 12640, 12641, 12662, 19893; of those collected and numbered by Vinal N. Edwards, V. N. E. 1405, 1412, 1413, 1417, 1420, 1423, 1462, 1466; of those collected and numbered by the author, W. 8, 10, 16, 22; from the haddock (*Melanogrammus aeglefinus*), lots 12611, 12626, 12640,

and W. 6; from the pollack (*Pollachius virens*), 12609, 12625, W. 1, 5, and 8; from the hake (*Urophycis chuss*), 12628, 12640, W. 2 and 23; from the hake (*Urophycis tenuis*), 6094, 6161, 6165; from the lumpfish (*Cyclopterus lumpus*), 12617; from the mackerel (*Scomber scombrus*), 12620, 12621, 12622; from the scup (*Stenotomus chrysops*), 12630, W. 20; from the striped bass (*Roccus lineatus*), 12613; from the alewife (*Clupea vernalis*), 12624; from the sturgeon (*Acipenser sturio*), 12623, W. 21; from *Acipenser brevirostrum*, 12610, 12615, 12618, 12629; from the sting ray (*Dasyatis centrura*), 6188; from the skate (*Raja harris*), 6163, 12608, 12633, 12637, 12642, 12643; from *Raja ocellata*, 6065, 6104, 6112; from *Raja erinacea*, 1399, W. 14 and 24; from the spiny dogfish (*Squalus acanthias*), 12639; from different sculpins, 8114; from the whiting (*Menticirrhus saxatilis*), 6164; from the shad (*Alosa sapidissima*), 12612; from the swordfish (*Xiphias gladius*), W. 12; from the rudder fish (*Kyphosus sectatrix*), taken in floating gulf weed, W. 11; from the sand shark (*Carcharias littoralis*), W. 9; from the remora (*Remora remora*), W. 13; from the crevalle (*Caranx crysos*), W. 15; from the cutlass fish (*Trichinurus lepturus*), W. 19; from the sand lance (*Ammodytes americanus*), one unnumbered lot. There is also a single specimen of the chalimus stage still attached to a small *Monacanthus* and numbered W. 20. Other specimens of the chalimus are numbered 6110, 6148, 6191, and W. 1. From the surface were obtained lots 6097, 6197, 8110, 12614, 12616, 12619, and W. 3, some of which contain several specimens. The National Museum also possesses a fine series of specimens from the Durham coast, England, contributed by the Rev. A. M. Norman, numbered 12906. These have been taken as the types of the species, and with them all the American forms have been carefully compared.

CALIGUS MUTABILIS, new species.

Plate VIII, fig. 2 in the text.

Female.—Carapace about three-sevenths the entire length, as long as wide, not narrowed anteriorly. Frontal plates well defined, but less than half the width of the carapace; lunules large, circular, and projecting. Posterior sinuses wide and slightly inclined away from the central axis. Median lobe much less than half the entire width and projecting only a little beyond the lateral lobes; the latter blunt and well rounded (fig. 90).

Thoracic area medium size, the anterior groove almost a perfect semicircle. Free thorax segment short and narrow, about one-fourth the width of the carapace, and contracted into a much narrower neck just in front of the bases of the fourth legs. Genital segment very variable, according to the age of the individual as well as the developmental stage of the eggs. In young females and in the adults before

the protrusion of the egg cases this segment is a broad flask shape, a little wider than long, with well-rounded sides, and a squarely-truncated posterior border. Its width under these conditions is fully three-fourths that of the carapace and sometimes more.

But after the protrusion of the egg cases it assumes an elongated spindle shape, wider posteriorly, and with a somewhat emarginate posterior border. In this condition it is about one-fifth longer than wide and narrows toward either end, its extreme width being less than two-thirds that of the carapace.

It is always contracted into a short, narrow neck where it joins the free segment, and is wrinkled across this neck as though segmented. The abdomen is short, but little more than half (0.64) the length of the genital segment in females with egg cases, and about one-third its width. It is two-jointed, the joints approximately the same length, but the anterior one a little wider.

Anal laminae small, well separated, and somewhat curved in toward each other. Egg cases short, half the length of the body, but about as wide as the abdomen, and each containing 50 eggs.

Anterior antennae short and closely appressed to the carapace; posterior antennae stout, with a swollen basal joint bearing an accessory spine and a strong terminal hook.

First maxillae medium size with a blunt point and an enlarged base; second maxillae very long and slender with an acuminate point. First maxillipeds with an exceptionally stout basal joint, which is fully three times the diameter of the terminal joint, this latter being the usual weak type, a little shorter than ordinary and tipped with two strongly curved claws. Furca a rounded Y-shape, the base being the same length as the branches, but much narrower, while the branches are stout, blunt, and strongly curved. First swimming legs short and stout, with the usual terminal claws, the small seta at the corner, and the three large plumose setae on the posterior margin of the terminal joint. But these plumose setae differ from those in most species in that the basal third is swollen in diameter and bordered not by plumose hairs like the tip, but with spine-like projections. The seta nearest the distal end has them on the outer margin only; the middle seta has about half as many on the inner as on the outer margin, while the inner seta has them on both margins equally.

The basal joint of the second legs is very much swollen, while the two branches are short and stout. The spines on the endopod are slender and acuminate. The rami of the third legs are large and stand out prominently from the edge of the basal lamina. The spine at the base of the exopod is also large, well curved, and blunt. The fourth legs are short and weak, not reaching to the center of the genital segment, three-jointed, with five spines of about the same length situated close together along the outer margin. The two terminal joints are

about the same length and diameter as the basal joint. At the bases of the spines are small semicircular laminae fringed with hairs like those in *C. rapax* and several other species. The fifth legs are not visible dorsally.

Total length 5.6 mm. Length of carapace 2.3 mm.; width of carapace 2.2 mm.; length of genital segment 1.9 mm.; length of abdomen 1.1 mm.; length of egg tubes 2.5 mm., 50 eggs in each.

Male.—Carapace a little more than half the entire length, longer than wide, otherwise similar to that of the female (fig. 91).

Free thorax segment bearing the same relation to the carapace as in the female, but being wider than the genital segment, owing to the diminution of the latter.

Genital segment a very narrow spindle shape, less than one-fourth the width of the carapace, and three fifths as wide as long.

It is wrinkled where it joins the free segment just as in the female, but is narrowed almost none at all, for it is already much narrower than the genital segment in consequence of its spindle shape. Abdomen the same length as the genital segment and two-thirds as wide, made up of two joints, of which the anterior is considerably shorter than the posterior and subspherical in shape. Anal laminae very large and foliaceous. Appendages as in the female except that the posterior antennae are branched, while the first maxillae are elongated into a long, slender hook, evidently used in prehension. The second maxillipeds are enlarged and form the chief organs of prehension. The fourth legs are relatively large and overlap somewhat the basal joint of the abdomen.

Total length 3.4 mm. Length of carapace 1.85 mm.; width of carapace 1.7 mm.; length of genital segment 0.7 mm.; width of same 0.43 mm.

Color a light horn yellow, delicately pencilled with pigment spots of pink and red, which are most prominent along the central axis of the carapace and in the posterior lateral angles.

(*mutabilis*, changeable, referring to the shape of the genital segment at different times.)

This species agrees somewhat with a variety of *C. gurnardi* figured by Kröyer (1863, pl. II, fig. 3, g), but the carapace is proportionally shorter and broader, the lunules are larger, and the furca is much more slender. The species *irritans* described by Heller (1865, p. 177, pl. xv, figs. 7 and 8) has similar large lunules, but a much narrower carapace and a very different furca. The species *isonyx*, Steenstrup and Lütken (1861, p. 358, pl. III, fig. 5), has very much the same proportions, but differs markedly in structural details.

It can be readily distinguished from other American forms by the simple fact that it is the only one having the abdomen about the same length as the genital segment and *two-jointed*.

It is not a very lively species, and thus far has a limited number of hosts. The National Museum collection includes several lots of specimens taken at different times, but all, with two exceptions, from similar hosts—the sea basses. As the scientific name of the host is not recorded in most of the instances, it can not be determined whether these hosts were all the same species or not. Lot 6155, consisting of ten males and females from the mouth of *Centroprius striatus*, is taken for the types of the new species. There is another lot, 6119, from the mouth of a “sea bass,” and six unnumbered lots, all from the mouths of “sea bass” at or near Woods Hole, except a single female from the mouth of a pollock and another from the mouth of a bonito.

CALIGUS ALIUNCUS, new species.

Plate IX.

Female.—Carapace elliptical, one-fifth longer than wide. Frontal plates distinct and very wide, not emarginate at the center; frontal margin nearly straight. Lunules large, semicircular, prominent. Posterior sinuses narrow and quite deep, leaving the median lobe nearly two-thirds the entire width; lateral lobes narrow and curved inward. Thoracic area very large, half the length of the carapace and more than two-thirds of the width (fig. 103).

Free thorax segment transversely linear, nearly as wide as the genital segment, but very short. Genital segment quadrangular, two-fifths as long as the carapace, a little wider than long, with short and blunt posterior lobes.

Abdomen one-fifth shorter than the genital segment, but more than half as wide, made up of four segments, of which the two end ones are about equal and considerably larger than the middle ones.

The terminal segment is deeply hollowed on either side posteriorly for the reception of the small, lateral anal laminae.

These latter are nearly spherical and do not reach beyond the tip of the abdomen; they each carry three long plumose setae posteriorly and a much shorter one on the outer margin.

Egg cases narrow, scarcely more than one-third as wide as the abdomen; eggs small and numerous.

The first antennae are a little longer than the frontal plates, the two joints about the same length, but the terminal one very much the narrower. Second antennae short and stout, with a broad terminal claw and no accessory spine. No trace could be found of the first maxillae. Second maxillae stout, broadly triangular, and nearly as long as the mouth tube.

The latter is broadly U-shaped, a little more than half as wide as long, and abruptly rounded at the tip.

Furca Y-shaped, the base longer than the branches and considerably constricted; branches thick, blunt, and divergent.

Claw of the second maxilliped less than half the length of the basal joint, slender, and strongly curved at the tip.

First thoracic legs tipped with the usual three claws but lacking the seta at the inner distal corner between the three terminal claws and the three posterior setae. The claws are short and stout, all of the same length, and all fringed on either side from the base nearly to the tip with a lamina or wing which is sharply serrate (fig. 109). Second legs ordinary, save that the large spines upon the exopod are each fringed with a serrate wing like those on the claws of the first legs. Rami of the third legs quite widely separated; claw on the exopod very large, nearly straight, and with a wide, nonserrate wing along either side, giving it a broadly spatulate outline.

Fourth legs large, reaching about to the posterior margin of the genital segment, four-jointed, with the usual five spines; but the spines upon the second and third joints are much larger and longer than usual, and, together with the three curved terminal spines, are fringed with a wide serrate wing along either side from the tip nearly to the base. There is in addition a peculiar appendage upon the outer distal margin of the basal joint. This consists of a thread-like or whip-like projection longer than the second joint, very pliable, and apparently muscular rather than chitinous. It is tipped with a long plumose seta and is evidently tactile, but what other function it may serve is a question. The fifth legs are situated just ventral to the bases of the egg cases, are very small, and do not project beyond the posterior border of the genital segment.

Total length 7 mm. Length of carapace 4 mm.; width of same 3.3 mm.; length of genital segment 1.5 mm.; width of same 1.7 mm.; length of abdomen 1.23 mm. Egg strings broken so that their length can not be determined.

Unfortunately there is but a single specimen—a female—as the exponent of this species. This specimen was taken at the surface under the attraction of an electric light. The label is one of the United States Bureau of Fisheries steamer *Albatross* labels, but no locality is given. But the specimen differs in so many particulars from other species of *Caligus* as to leave no doubt of its validity. There is only one other species of *Caligus* known, *C. coryphænx*, in which the abdomen has four joints, and in that species the size and proportions of the free and genital segment are entirely different. The winged margins on the claws and spines is another distinctive feature, and is the one which has suggested the specific name.

(*aliuncus*—*ala*, a wing, and *uncus*, a claw.)

CALIGUS CURTUS Müller.

Plate X, figs. 8, 24, 28 in the text.

Caligus curtus MÜLLER, 1785, p. 130, pl. XXI, fig. 1.—SMITH, 1874, p. 575.—RATHBUN, 1884, p. 486.

Caligus mulleri LEACH, 1816, p. 405, pl. XX, figs. 1-8.—DANA, 1854, p. 1352.

Caligus bicuspidatus NORDMANN, 1832, II, p. 17.

Caligus americanus PICKERING and DANA, 1838, p. 65, pls. III, IV, V.—DANA, 1854, pl. XCHL.

Caligus diaphanus BAIRD, 1850, p. 269, pl. XXXII, fig. 1.

Caligus elegans VAN BENEDEEN, 1851, p. 91, a male.

Female.—Carapace somewhat longer than the rest of the body, obovate. Frontal plates distinct, the anterior margin well rounded and incised at the center. Lunules large and circular, not very widely separated and not projecting. Posterior sinuses narrow, shallow, and with nearly parallel sides; the median lobe less than half the entire width, projecting for two-thirds of its length beyond the lateral lobes; the latter broad and well rounded (fig. 113).

Thoracic area quadrilateral, comprising about one-third of the carapace; its anterior groove nearly straight. Eyes small and situated far forward. Free segment short and very narrow, not more than half the width of the genital segment, and spindle-shaped. Genital segment oblong, half as long as the carapace, with parallel sides and well-rounded corners. There are no lobes on this segment and the fifth legs are not visible dorsally. Abdomen short, half as long as the genital segment, often slightly swollen at the center. Anal laminae rather small with very long setae; egg strings wide and about as long as the entire body.

Anterior antennae large, the basal joint much longer and wider than the terminal and both joints plentifully supplied with setae and spines. These antennae stand out very prominently from the carapace. Second antennae stout, with a long accessory spine on the inner border of the terminal claw, near its base.

First maxillae of good size and situated close to the edge of the carapace, the terminal portion strongly curved and the base considerably swollen. Second maxillae broadly triangular with curved sides, abruptly narrowed near the tip into an acuminate spine. This represents the endopod of the appendage, while upon the ventral surface of the base of the triangle is the rudimentary exopod, consisting of a long, slender spine and three or four small setae. This exopod is articulated with the base of the endopod and is capable of considerable motion.

The mandibles are curved inward and dentated along the inner edge, the number of teeth being about fourteen.

First maxillipeds very slender and weak, the terminal joint much longer and narrower than the basal, with a short spine on its inner margin near the distal end. The two claws at the tip of these append-

ages are doubly edged with a finely pectinated membrane. Second maxillipeds large and stout, the basal joint much swollen and at least a third longer than the terminal claw. Furca short and very stout, the base longer than the branches, which are straight and slightly divergent, the same diameter throughout and very blunt at the tips.

Of the swimming legs the three terminal spines at the tip of the first pair are short, obtuse, and about the same length.

The seta at the outer corner is also short and naked; the plumose setae on the posterior margin are large, with very short pinnules on the outer margins, but of the usual length on the inner.

The rami of the third legs are large, well separated, and closely approximated to the margin of the basal apron, the claw at the base of the exopod being of medium size and rather blunt.

The fourth legs are three-jointed, with four spines, one at the extremity of the second joint and three at the tip, all well curved. The first three are small and of approximately the same size, the fourth (the inner terminal) one is nearly three times as long and toothed on its outer margin. The two short terminal spines are edged along either side with a pectinated membrane. There is also a short semi-circular membrane with a sharply serrated margin projecting like an epaulette over the base of each of these three spines.

The fifth legs are so small as to be invisible dorsally. Total length 8–12 mm. Length of carapace 6.1 mm.; width of same 5.9 mm.; length of genital segment 2 mm.; length of abdomen 1.2 mm.; length of egg strings 14 mm.

Color a uniform transparent horn color, often marked in older individuals with numerous dendritic delineations of an ocher yellow. A short time after death the copepod assumes an entire change of color, becoming a deep rose red. This new color is disposed in dendritic delineations corresponding to those of the ocher yellow and in all probability the yellow is changed into the red during dissolution (*curtus*, shortened.)

Male.—Carapace broad ovate, as wide as long, strongly narrowed anteriorly. Posterior sinuses inclined toward the central axis; median lobe wider than in the female; lateral lobes plump and well rounded. Free segment as wide as the genital segment, but with the same spindle shape as in the female. Genital segment orbicular with well-rounded sides and posterior margin, a trifle wider than long, with the fifth legs showing prominently at the posterior corners. It is much smaller than in the female, being only one-third the length of the carapace.

The abdomen is a little longer than the genital segment, contracted where it joins the latter, and considerably swollen at the center. Anal laminae very large and foliaceous (fig. 112).

Of the appendages the second antennae and second maxillipeds are the only ones requiring special mention.

The second antennæ are much longer than in the female and three-jointed; the basal joint is broad and oblong and is attached to the ventral surface by its long posterior side. At its inner extremity it turns upward to receive the following joint. The second joint is broad and well rounded; its entire inner and ventral surface is covered by a swollen pad formed of chitin ridges overlapping one another like clapboards on a house, giving an admirable rasp-like surface for the prevention of slipping (fig. 123).

The terminal joint is obliquely articulated with this second joint and is much smaller and shorter. It terminates in two stout claws, widely divergent and quite strongly curved.

There is a slender seta on the outer margin and another on the inner surface near the base.

The second maxillipeds are much enlarged, the basal joint being swollen with a width considerably more than half its length (fig. 124).

The terminal claw is less than half the length of the basal joint, but is stout and furnished with powerful muscles. Its tip shuts into a socket formed at the base of a large spine on the ventral surface of the basal joint, affording a strong grip. Between this spine and the base of the terminal claw there is another shorter and smaller spine with an acuminate tip. This shuts in past the side of the terminal claw when the latter is closed and thus strengthens the hold. The other appendages are like those in the female.

This species is one in which the males are larger than the females, as can be seen in the following measurements:

Total length 13–20 mm.; length of carapace 7.5–12 mm.; width of same 7.4–11.5 mm.; length of genital segment 2.5–4 mm.; length of abdomen 2.5–4 mm.

Chalimus, later stages.—Carapace narrow ovate, much longer than wide, about 0.64 of the entire length, contracted considerably through the frontal plates. Posterior sinuses narrow and slit-like; median lobe projecting nearly its entire length behind the lateral lobes (fig. 115).

Posterior portion of the body very narrow and of nearly the same diameter throughout. Free segment of good length and well rounded at the sides; genital segment also well rounded, with the fifth legs showing on either side near the posterior end.

Abdomen a little narrower, but with well-rounded sides; anal laminae large and broad.

The lunules appear early upon the frontal plates and are large and semicircular in outline. The eyes are small, highly colored, and placed relatively much farther back of the frontal margin than in the adult. The appendages are nearly the same as in the adult.

Chalimus, early stages.—Carapace, a still narrower ovate, becoming sharply pointed in front. This latter is due almost entirely to the frontal plates, whose width is more than one-third the length of the

carapace. They taper forward to a sharp point at the base of the frontal filament as though pulled out by the latter. The two terminal joints of the first antenna are attached to the posterior border of the frontal plates, giving them the appearance of being attached to the lateral margin of the carapace, well back toward its center (fig. 114).

The eyes are so far back as to be a little behind the apparent center, though they are not far from the actual anterior margin of the carapace. There are no posterior sinuses, the third thorax segment not having yet fused with the head. This leaves the posterior margin of the carapace concave, the posterior corners projecting somewhat. The third thorax segment is separated by a well-defined groove from the carapace; it is a little wider, but only half as long as the fourth segment, and from its well-rounded sides project the third swimming legs.

The latter have not yet acquired their broad basal apron, but are almost exactly like the second pair, and the exopods can be plainly seen in dorsal view. The fourth segment is long and large, with well-rounded sides; the fourth legs are attached near its posterior margin and are quite rudimentary.

The genital segment and abdomen are still fused, though the line of separation is indicated by a deep indentation on either side.

The anal laminae are small but the plumose setae are long and stout.

The total length of the earliest stages is only a trifle over 2 millimeters, of which the carapace, including the frontal plate, makes up about four-sevenths.

This species occurs very frequently and often in great abundance upon the codfish of our coast, but has been rarely observed on other species of fish. Most of the specimens in the collection of the National Museum agree closely with the *Caligus americanus*, so well described by Pickering and Dana (1838).

But there are a few lots of females in which the abdomen is broader and more nearly quadrangular. A careful examination of these specimens, however, fails to reveal the slightest differences in the appendages and hence they can not be regarded as even a variety. This is one of the species upon which Müller founded the genus *Caligus* in 1785, and is the only one of the types which has proved to be a real *Caligus*, the others belonging to other genera. Hence the present species is left as the sole type of the genus.

Many lots of specimens have been obtained by the United States Fish Commission from codfish taken along the New England coast from Maine to New York, and on the offshore fishing banks. They are exceedingly abundant during the autumn of the year when the shoal-water fish are brought into the local markets, and they gradually diminish as the season advances. They are most numerous on half-grown fish and may be found anywhere upon the external surface or the fins. They are also rarely taken in company with *C. rapae* in the

mouth, but never, to the author's knowledge, within the gill covers. They are not as active as *rapax*, but upon occasion can move about with equal speed and facility. They live but a short time after being taken from their host since they exhibit to a marked degree the pernicious habit of crawling up out of the water and remaining there until dead. They are also very susceptible to a slight rise in temperature; Pickering and Dana say (p. 67) that "when the temperature has been as high as 60° F., they have generally died in the course of a short time." The author's experience has been similar, although no actual temperature tests have been made.

Being susceptible to so slight a rise it becomes extremely difficult to handle them during the summer months, when most of the research work is being done at the Marine Biological Laboratories. It is not surprising, therefore, that so little has been ascertained in regard to their habits and development, even though they are so common.

The Museum collection includes the following:

From the codfish (*Gadus morhua*) of Woods Hole and the immediate vicinity four lots numbered 11618, and one each 12305, 12649, 12650, Acc. no. 19893, and the following collected by Vinal N. Edwards, 1301, 1384, 1393, 1417, 1423, 1463, 1466, 1485. These lots include something like 250 specimens. From codfish off the coast of Maine, chiefly near Casco Bay, lots 8022, 8023, 8024, 8025, 12646, 12653, 12654, 12655, 12660, 12661, 12907, nearly 200 specimens more. From codfish in Massachusetts Bay lots 12656, 12657, 12658. From other localities, chiefly stations of the U. S. Bureau of Fisheries vessels *Albatross* and *Grampus*, lots 16644, 12645, 12647, 12648, 12671, 12672, 12673, and W. 31. From the haddock (*Melanogrammus aeglefinus*) lots 12307, 12651, 12659, W. 25, W. 26, W. 41. From the hake (*Urophycis tenuis*) lots 8026, 13203, W. 30. From the halibut (*Hippoglossus hippoglossus*) 12631. From the pollack (*Pollachius virens*) W. 27, W. 28, W. 29. From the barn door skate (*Raia lævis*) 858, 6162. From the surface 12908 and W. 32. Specimens of the chelimus of this species are included in lots W. 36 from the tomcod; W. 37 host unknown, and 8116 from fin of codfish.

CALIGUS CHELIFER, new species.

Plate XI.

Female.—Carapace ovate, a sixth to a quarter longer than wide, considerably narrowed anteriorly. Frontal plates well defined; lunules large, close together, nearly circular, and prominent (fig. 126).

Posterior sinuses wide and nearly parallel; median lobe half the entire width, projecting considerably, and contracted into a narrow neck where it joins the free segment.

Thoracic area two-thirds the width and one-half the length of the carapace, subquadrilateral. Free thorax segment very short, a little

wider than the neck of the median carapace lobe which joins it anteriorly, and passing insensibly into the genital segment posteriorly. Genital segment acorn-shaped, the anterior and posterior margins straight and parallel, the former about half the latter, contracted strongly where it joins the free segment. In the alcoholic specimen the dorsal surface of this genital segment has a row of three pits or depressions on either side of the midline, the two central ones being connected across the midline by a groove which is convex anteriorly, while the two anterior ones are joined similarly by a straight groove. In the living specimens obtained by the author these pits and grooves were almost invisible and would never have been noticed had not the alcoholic specimen been studied first.

Abdomen narrow and two-jointed, four times as long as wide, the terminal joint two to two and a half times the length of the basal. The latter is enlarged where it joins the genital segment and tapers somewhat toward the distal joint which has parallel sides. The posterior end of this distal joint is wedge-shaped and the anal laminae are attached to the sides of the wedge. They are long and narrow, cylindrical in form, and curved in toward each other at the tips, while the plumose setae which they carry are fully as long as the entire abdomen.

The egg cases are the same width as the abdomen and about half the length of the entire body. The eggs are quite thick and number 45 or 50 in each case.

Of the ventral appendages the anterior antennae are small, with the two joints about the same length. The posterior antennae are slender, the terminal claw being but little longer than the basal joint. The accessory spine behind the base of this antenna is long and sharp.

The first maxillae are small, only slightly enlarged at the base and with a blunt tip. The second maxillae are simple, quite long and nearly straight; each carries upon its base a raised papilla from whose summit project two divergent setae representing the exopod of the appendage as in *U. rapax* and several other species. First maxillipeds of normal size and structure, bearing a small spine on the anterior margin of the distal joint near the tip, and terminating in two curved and winged claws of unequal length. The second maxillipeds are peculiar. The basal joint is very large and as wide as it is long. It sends out two protuberances on the inner margin, a large one at the base which is hemispherical in form with a flattened tip, another still larger at the distal end. This latter is broad and finger-like and extends outward along the inner curve of the terminal claw, forming an inarticulate half of a large chela, very similar to those borne by other crustacea. It is notched at the tip where it is also covered with short and stiff spines, making a rough surface admirable for retaining a firm hold. The terminal claw is about two-thirds the length of the basal

joint, very stout, and furnished with a short accessory spine on the ventral surface (fig. 130).

This claw is operated by powerful muscles contained in the basal joint and it must make an effective prehensile organ.

Furca long and narrow, the base longer than the branches, the latter of a broad U-shape with the sides nearly parallel.

The first thoracic legs are so small and weak as to appear shriveled; this is especially noticeable in the plumose setae along the posterior margin of the terminal joint, which are scarcely longer than the diameter of the joint. In the alcoholic specimen taken from the menhaden the two posterior of the three terminal claws are branched, the branches being straight, longer than the tips of the claws, and inserted nearly at right angles to the axis of the claw (fig. 133). In the living specimens obtained by the author from the sword-fish the claws are mostly unbranched, but are of the same relative size as in the menhaden specimen.

In all the specimens the appendage at the inner corner of the joint is a long, strongly curved claw instead of a plumose seta.

This is similar to the condition in *schistonyx*, but the relative size of the claws and the seta is entirely different in the two species. The second legs are large, of normal structure, and armed with long acuminate spines. The rami of the third legs are well separated, the claw on the basal joint of the exopod is large and slightly curved, while the endopod is one-jointed.

The fourth legs are three-jointed, long and slender, the basal joint as long as the other two. This leg carries five spines, one at the distal end of the second joint, one on the outer margin of the terminal joint and three at the end.

Of the latter the inner one is about twice as long as the outer.

The fifth legs are not visible dorsally.

Total length in menhaden specimen 5 mm. Length of carapace 2.5 mm.; width of same 2.1 mm.; length of genital segment 1 mm.; length of abdomen 1.4 mm.

Total length of swordfish specimens 6-6.5 mm. Length of carapace 3 mm.; width of same 2.3 mm.; length of genital segment 1.6 mm.; length of abdomen 1.45 mm.; length of egg strings 3.2 mm.; 45 or 50 eggs in each.

Color a transparent yellow, very thickly spotted on both the dorsal and ventral surfaces with branching pigment dots of a rusty brown. These spots are quite similar to those on *U. rapax* in shape and arrangement, but the resultant color is a sober gray brown quite different from the bright red tint of *rapax*. In fact, there is enough difference in the color alone to distinguish the two species when taken together on the swordfish.

(*chelifer*, *chela*, the pincher-like claw of crustacea, and *fero*, to bear or carry.)

The National Museum collection when sent to the author contained but a single specimen, a female, of this species. It was numbered 6079, and was obtained from the external surface of a menhaden at Woods Hole by the United States Fish Commission. The characteristics of this specimen, especially the pincher-like claw, were so different from other species that it was decided to make it the type of a new species. Much to the author's gratification he was fortunate enough to obtain several living females from swordfish captured off Gay Head, Marthas Vineyard, in July, 1904. They were found on the external surface in connection with *C. rapax*, but were not nearly as numerous as that species, only five being obtained from four swordfish.

A single female taken from the cutlass fish (*Trichiurus lepturus*) on September 16, 1903, by V. N. Edwards, was afterwards placed in the author's possession. From the living specimens several facts were ascertained, which have been incorporated in the previous description. In addition it may be said that the species is almost as lively as *rapax*, swimming about restlessly when kept in an aquarium. That it has never been captured in the tow is probably due to the fact that its chief host, the swordfish, is an off-shore fish. So far as known this is the only instance of a *Caligus* having anything which may fairly be called a chela. Many other species have protuberances of various sorts on the inner margin of the basal joint of the second maxillipeds, but they are simple protuberances and do not in any way extend outward alongside the terminal claw and in opposition to it. Here, on the contrary, it is to be noted that the conditions reproduce exactly those in higher crustacea. The outer, swollen branch of the chela is articulated at its base, while the inner, larger branch is inarticulate and forms a part of the preceding joint. In place of the rounded teeth so commonly found on this part of the chela we have here short and stiff spines. In the living specimens the chela was frequently opened and closed, the tip of the claw, in the latter instance, folding down over the end of the protuberance so tightly that the two seemed all one piece.

The comparative measurements of the menhaden and swordfish specimens furnish a good object lesson on the shrinkage which results from preservation in alcohol.

One of the specimens was a female without egg-strings, and in this condition the genital segment becomes so rounded anteriorly and posteriorly as to be nearly a perfect circle in outline. The species may be easily recognized by the shape of the anal laminae and the length of their plumose setae. An examination of the tips of the second maxillipeds will then verify the diagnosis beyond a doubt.

CALIGUS BELONES Kröyer.

Plate XII, figs. 135-139.

Female.—Carapace about half the entire length, a little longer than wide. Frontal plates prominent, the anterior margin almost straight, with very little incision at the center. Lunules large and widely separated, strongly inclined toward the mid line, and subprominent. Posterior sinuses wide and shallow, leaving a median lobe less than half the entire width, and projecting but little behind the lateral lobes. Thoracic area about half the dorsal surface of the carapace, well rounded anteriorly. The digestive glands in this area are pear-shaped and inclined toward each other anteriorly.

Free segment short and strongly contracted where it joins the carapace. Genital segment elliptical, one-third the entire length, emarginate posteriorly, with short and blunt lobes. Fifth legs not visible dorsally.

Abdomen elliptical, less than half the width of the genital segment, nearly twice as long as wide. It is contracted to almost half its width where it joins the genital segment. Anal sinus broad and deep. Anal laminae large, one-fourth as long as the abdomen, sublateral, with long plumose setae.

Egg tubes half the width of the abdomen and a little longer than the carapace, 30 or 40 eggs in each.

Anterior antennae short, the two joints about the same length, but the terminal joint very slender and closely appressed to the frontal margin. The basal joint is plentifully supplied with plumose setae and the terminal one with spines.

Second antennae small and short; basal joint nearly as long as the terminal, the angle in the latter very close to the tip.

Accessory spine large and stout. First maxillae long, slender, and well curved; second pair little more than half as long as the mouth tube, rather slender and blunt at the tip, but much widened at the base. Mouth tube quite stout, a little longer than wide, well rounded at the tip. First maxillipeds slender, the two joints almost equal in length; second pair stout, with a short and blunt terminal claw. Furca long and wide, the base elongate, very narrow, and about as long as the branches, the latter stout and curved into the shape of a horseshoe, of the same diameter throughout.

Rami of the third pair of thoracic legs well separated, large and prominent; the spine at the base of the exopod slender and nearly straight. The fourth legs are half the length of the genital segment, three-jointed with four spines; basal joint stout and as long as the two terminal joints, which latter are very slender. Second joint longer than the third, with a slender terminal spine; the three ter-

minial spines on the last joint graded in size, the inner one twice as long as the outer.

Total length 5 mm. Length of carapace 2.6 mm.; width of same 2.3 mm.; length of genital segment 1.4 mm.; length of abdomen 1 mm.; length of egg strings 3 mm.

Color a light yellowish brown without pigment (in preserved specimens).

(*belones*, generic name of one of its hosts.)

The National Museum collection includes a single lot of this species from the body of a small dolphin (*Coryphæna equisetis*), without a number, and with the locality not given.

But as the label bears the signature of Mr. Vinal N. Edwards, and was given to the author with other material collected at Woods Hole, it is probable that the dolphin was caught in the North Atlantic. The lot includes two females which resemble Krøyer's species so closely as to leave no doubt of the identity. Krøyer states that in his specimens the abdomen was indistinctly segmented, but these two show no sign of segmentation. The furca on these specimens is also somewhat different but not enough so to warrant specific distinction. In all other particulars the two lots agree perfectly. The present host, the small dolphin, is a new one, this species having been found previously upon *Belone vulgaris*, on what Krøyer calls the "Hornfish," and on what Olsson designates as the "Beak fish." It is more of a tropical than a northern species.

CALIGUS LATIFRONS, new species.

Plate XII, figs. 140-149.

Female.—Carapace half the entire length, a little longer than wide, considerably narrowed anteriorly. Frontal plates very wide and prominent; lunules large, almost circular in outline, and projecting far in front of, and laterally over the bases of, the first antennæ. Eyes large and situated far forward close to the anterior margin of the carapace. Posterior sinuses wide and oblique, leaving a median lobe five-eighths the width of the carapace and quite squarely truncated posteriorly. Lateral lobes narrow and curved inward at the tip. Thoracic area seven-eighths the entire width of the carapace and almost exactly one-half the length, the anterior groove flattened similarly to the posterior margin of the median lobe.

Free thorax segment two-thirds as wide as the genital segment, abruptly narrowed in front of the fourth legs.

Genital segment nearly quadrate with well-rounded corners, a little more than half as long as the carapace and not quite half as wide. Abdomen about four-fifths the length of the genital segment, one-half longer than wide, swollen at the center, and narrowed at either end.

Its posterior margin is wedge-shaped so that the small anal laminae are joined sublaterally.

Each of these latter carries four plumose setae which are small and short. No egg strings present in this female.

Of the ventral appendages the first antennae are elongate, with the longer terminal joint very slender. Both joints are turned backward and closely appressed to the anterior margin of the carapace. The second antennae have a long and slender terminal claw and a rather small basal joint.

Posterior to the base of these antennae is a stout accessory spine which is relatively larger than in most species.

The first maxillae are small and almost straight, with the base enlarged scarcely at all; the second maxillae are elongate, stout and blunt at the tip. Furca large, the base about the same length as the branches and nearly square, with a transversely semilunar foramen. The branches are slender, blunt, and curved in toward each other. Second maxillipeds stout, the terminal claw about four-fifths as long as the basal joint, the latter not swollen. The accessory spine on the terminal claw is short and weak. First swimming legs stout, with a long plumose seta on the distal end of the basal joint and a short spine on its posterior border near the proximal end.

On the terminal joint the three claws are about the same length and not very strongly curved. The outer one is smooth and nonserrate; each of the other two is branched at about its center on the inner side. The branches are more slender than the tips of the claws and extend some little distance beyond them. They are also perfectly transparent, while the claw itself is more or less opaque. The plumose setae on the posterior border of this joint and the seta at the inner distal corner are like those in other species.

The spines on the exopod joints of the second legs are long and acuminate and are bent inward at nearly right angles to the outer margin; the basal joint of these legs is strongly flattened and is relatively wider than in most species.

The rami of the third legs are widely separated, the exopod being turned inward along the posterior border of the basal joint.

The claw on this exopod is large and stout, about the same diameter throughout, with straight sides.

The fourth legs are long and stout, the basal joint nearly as long as the two terminal ones. There are five spines—a large one at the tip of the second joint, a much smaller one on the outer margin of the terminal joint, and three at the tip—increasing in size from without inward, the inner one more than twice the length of the outer. There are foliaceous projections fringed with long hairs at the bases of the first, second, third, and fifth spines and at the inner distal corner of the terminal joint. These are almost exactly like those on *C. rapax*,

but are arranged differently. The fifth legs are so small as to be invisible in dorsal view.

Total length, 4.9 mm.; length of carapace, 2.46 mm.; width of same, 2.2 mm.; length of genital segment, 1.25 mm.; length of abdomen, 1 mm.; egg strings not present.

Color of specimen preserved in formalin a pale dusky yellow with a large brown area in the center of the dorsal surface of the genital segment, and the two glands in the thoracic area also brown.

(*latifrons*, *latus*, wide, and *frons*, forehead.)

This species resembles *rapax* very closely in its general appearance, but is clearly distinguished from it by the size and shape of the furca, by the relative width and length of the median carapace lobe and the free thorax segment, and by the details of the first swimming legs, particularly the divided claws. From *schistonyx*, which has the claws divided, this species is distinguished again by the size and shape of the furca, by the great difference in the relative size of the terminal claw on the second maxillipeds, and by the detail of the exopods of the third and fourth legs.

From *chelifer*, which also has the claws divided, it is easily told by the simple fact that its abdomen is unsegmented, while that of a female chelifer is two-jointed. There is also a very essential difference in the structure of the second maxillipeds, in the furca and in the fourth legs. In spite of the fact, therefore, that the collection includes but a single female for which neither the host nor the locality is given, there must be established for it a new species.

CALIGUS BONITO, new species.

Plate XIII, figs. 150–153; figs. 5, 12, 13, 14, 15, 29, 30, 35, 37, 38, 40–45 in text.

Female.—Carapace orbicular, with the sides somewhat flattened, the same length and width; posterior sinuses shallow, slightly curved and enlarged at the base. Thoracic area broad, more than half the entire width, somewhat flattened posteriorly and scarcely projecting beyond the lobes; the latter narrow and curved inward (figs. 150, 151).

Free thoracic segment short and very narrow; much constricted in front of the fourth legs. Genital segment elliptical, two-thirds as wide and nearly as long as the carapace, projecting posteriorly in the form of a blunt, conical lobe on either side of the abdomen. Abdomen somewhat spindle-shaped, more than three times as long as wide, and two-jointed; the joints about equal in immature females, and presenting a very close resemblance to that of the males, but the basal joint three times as long as the terminal in fully developed individuals and the segmentation very indistinct.

Anal sinus scarcely perceptible; anal laminae of good size, quadrangular in outline, each terminated by five plumose setae.

Of these the outer and inner ones are very short, while the three central ones are of the same length, which is nearly three times that of the papillæ.

First antennæ short, particularly the basal joints; frontal plates wide but not very long; lunules orbicular, close together on either side of the median line, projecting considerably, and occupying nearly the whole of the frontal plates. The median joint has nearly the outline of an equilateral triangle, while the terminal joint is slender and club-shaped.

Second antennæ stout, the terminal joint a long, sickle-shaped hook attached nearly at right angles to the basal joint (fig. 5, p. 500).

First and second maxillæ comparatively rudimentary, the former with a slightly swollen base. Mouth tube broad, with the opening elongated transversely and densely fringed with hairs. Mandibles with a row of rounded teeth along the anterior and posterior margins for some distance back from the tip.

Furca stout, with an accessory spine on either side at the base. First maxillipeds long and slender; second pair of medium size, the basal joint much longer than the terminal, the latter consisting of a stout, curved claw, with a slender spine at about the center of its inner margin (fig. 12, p. 504).

First swimming legs with a stout basal joint whose ventral surface is nearly covered by a broad chitin plate. From the posterior margin of this plate project a slender acuminate spine at about the center and a stout blunt papilla at the outer corner (figs. 13-15).

The endopod is represented by a small, slightly curved spine. The second joint is long and considerably swollen at the center.

The terminal joint carries three plumose setæ in the usual position on the posterior margin, the bases of the setæ being pectinated. The three terminal claws are the same length, while the seta at the corner is plumose and three times as long as the claws.

The second swimming legs are not noticeable except for a row of short, pectinate spines along the outer margin of the two proximal joints of the endopod. The third swimming legs have a particularly large and stout curved claw at the base of the exopod. The fourth legs are large and strong for so small a copepod; the distal joint bears three long curved spines at its tip and a smaller one upon its posterior margin; the penultimate joint carries a single stout spine at its distal end on the posterior margin.

The rudimentary fifth legs are not visible dorsally in either male or female.

Total length, 8.3 mm.; length of carapace, 3 mm.; width of same, 3 mm.; length of genital segment, 3 mm.; length of abdomen, 2.3 mm.; length of egg strings, 8 mm.

Color a pale transparent yellow without any pigment, except at the tips of the lateral lobes and the adjacent thoracic area, which are thickly spotted with light, rusty brown.

The copepod thus appears as if it had two large brown eyes, one on either side of the body at the posterior end of the carapace, and it may be readily recognized by these, since no other species is marked similarly.

(*bonito*, the name of its host.)

Male.—Considerably different from the female. The carapace is more nearly orbicular, while the thoracic area is much narrower (fig. 152).

This gives the posterior end of the carapace a rounded appearance quite different from the truncate look of the female.

The free thoracic segment is much wider posteriorly than anteriorly, and projects so far beyond the sides of the genital segment that the fourth legs are attached to its posterior rather than its lateral margin. The genital segment is but little wider than the abdomen and quite fusiform, the anterior end being usually well wrinkled. The abdomen is the same length as the genital segment and is jointed once near the center.

These alterations in shape produce equally marked changes in the proportions of the various parts. Whereas in the female the proportion in length between the cephalothorax and the remainder of the body (exclusive of the egg strings) is as 7 to 10; in the male the same proportion is as 7.5 to 6.5. This change is far more than usual. The first antennæ are relatively larger and longer than in the female, this being particularly true of their basal joints with the lunules.

The second antennæ are not as stout as those of the female, but the first maxillæ are nearly three times as large. This makes the two appendages in the male nearly the same size, the maxillæ being a trifle longer but not as stout.

In the second maxillipeds the basal joint is reinforced at its distal end by a thick, bony plate on the inner side. The powerful terminal claw, folding down against this plate, makes a very effective clasp organ.

Total length, 5.5 mm. Length of carapace, 3 mm.; width of same, 2.8 mm.; length of genital segment, 1 mm.; length of abdomen, 1.2 mm.

Nauplius.—The newly hatched nauplii are large and active. They are rather elongate in form, the length being nearly three times the width, and the body is bluntly rounded both anteriorly and posteriorly (figs. 37, 38 in text). The three pairs of appendages have the typical nauplius form. The labrum is oval in outline, with a broad, shallow sinus on either side and in front, but with a wide, blunt projection posteriorly. The body is pigmented with rusty brown in narrow patches all along either side and posteriorly, the patches being irregularly disposed. Sometimes these pigment patches are fused into an

irregular marginal band. And often the pigment extends out into the antennules almost to their distal end and into the basipods of the other two pairs of appendages. The balancers on either side of the anus are long and stout (0.12 by 0.01 mm.), their length exceeding that of the anterior appendages, exclusive of their setæ. They are widest at the center and taper somewhat toward either end. The basal third is cylindrical in shape, while the terminal two-thirds is flattened or compressed into a knife-blade form, the whole resembling in shape the common form of paper cutter made from a cylinder. At the first moult the skin over these anal appendages is shed exactly like that over the others, but at the second moult the entire appendages disappear.

After the first moult also the pigment extends in toward the center of the body, and by the second moult has become quite evenly distributed.

Metanauplius.—Body elongated and narrowed, carapace covering two-thirds the entire length (fig. 40 in text). Carapace elliptical, well rounded anteriorly, narrowed and emarginate posteriorly. Three free thorax segments and a terminal segment representing the genital segment and abdomen, as yet unseparated. The eyes are placed far back, near the center of the carapace, and are fused on the mid line, as in the adult. The rusty brown color covers a wider space along the margin and is more uniformly disposed than in the nauplius. In place of the three pairs of nauplius appendages there are five pairs of thorax appendages.

Anterior antennæ are two-jointed, bearing long setæ on the terminal joint, irregularly disposed; basal joint closely approximated to the anterior margin of the carapace.

Second antennæ biramous; exopod short and rudimentary, ending in a short spine; endopod longer and stouter, terminating in a curved claw nearly as long as the endopod itself, and bent over ventrally until its tip nearly touches the basipod (fig. 42 in text).

First and second maxillæ very rudimentary, the former a mere protuberance near the margin of the carapace, the latter consisting of a single conical spine at the side of the mouth (fig. 43).

First maxillipeds shorter and stouter than in the adult, tipped with three strong spines or claws, the two inner of which are pectinated. Second maxillipeds longer and more slender than in the adult, projecting far beyond the edge of the carapace, the terminal claw with an accessory spine on its inner margin.

First two pairs only of the swimming legs present on the first two free thorax segments; both pairs rudimentary, biramous, the terminal joints fringed with plumose setæ (figs. 44, 45). Total length, 0.67 mm. Length of carapace, 0.42 mm.; width of same, 0.22 mm.

This small species is very abundant upon the common bonito (*Gymnosarda pelamis* Linnaeus), but has not been found thus far upon any other fish. It frequents both the mouth and the gill cavity, more com-

monly the latter, and in extremely rare instances may be found upon the external surface near the head.

While bonito are frequently taken upon which not even a single specimen of this parasite can be found, there are just as often others which fairly swarm with the diminutive pests. As many as one hundred can sometimes be secured from a single large fish.

They are very lively and scuttle about rapidly over the inside surface of the gill cavity and the mouth, while the sucking disks are so large that they can be removed only with considerable difficulty. They move about constantly when put into sea water, but have two pernicious habits. The first is one common to many species of this genus and quickly results in suicide. It consists in swimming to the side of the dish or aquarium and crawling an inch or an inch and a half above the surface of the water, there to remain until thoroughly dried.

This renders it very difficult to keep specimens alive for any length of time. Indeed it is practically impossible unless they are placed in a wide-mouthed bottle over whose mouth is tied a piece of fine gauze, the whole being sunk beneath the surface of the water in the aquarium.

The other disagreeable habit is confined to the female and consists in sloughing off her egg strings as soon as she is placed in fresh sea water. This renders it impossible to allow the eggs to mature and the larvæ to hatch. If the eggs have not developed sufficiently for the larvæ to emerge when the female is captured, there is practically no hope of maturing them.

If, however, the eggs are just ready to hatch when captured, the female apparently makes an exception of the emergency and retains the egg cases until the larvæ have all escaped.

This species was first obtained at Woods Hole in the summer of 1883 by Richard Rathbun, who made many drawings and notes upon its habits and anatomy. These, however, were never published, but, together with one or two drawings by Emerton, were recently turned over to the author and have been incorporated in the present account. Mr. Rathbun had named the species *Caligus bonito* in his manuscript, and this name has been retained (*bonito*, the name of its host).

A study of the development of this species is of peculiar interest for the light which it throws upon the morphology of the adult. The nauplius and metanauplius have already been described in detail; the chalinus has not yet been obtained, but specimens have been secured which had just moulted from the chalinus stage. In them the carapace is proportionally much larger than in the adult, while the genital segment is very much smaller. Indeed, so great is the difference between females in these two stages that the younger immature specimens resemble the males more than they do the adult females, and would

ordinarily be taken for males. The anterior portion of the genital segment, where it joins the free segment, is contracted into quite a long neck, well creased with wrinkles.

The body of the segment is not much wider than the abdomen and is almost squarely truncated posteriorly without any lobes at the corners. The abdomen is considerably shorter than in the adult and is plainly segmented at about the center—i. e., it is practically the same as in the male. There is not the slightest doubt that these are really young females, for the egg strings can be seen forming inside the genital segment, and the second antennæ and second maxillipeds have the structure of those in the female and differ much from those in the male.

The examination of these developing females led plainly to the conclusion that the abdomen is segmented in the adult, although the segmentation is usually very well concealed.

Accordingly a large number of adults were carefully examined with the result that two were found which showed a segmented abdomen very plainly. As development proceeds the genital segment widens and lengthens, sending out large lobes from the posterior corners; at the same time the abdomen lengthens, the increase taking place almost wholly in the basal segment.

Thus while in the immature female the segments of the abdomen are about equal, in the adult the basal segment is three or four times the length of the terminal.

This development also suggests an explanation for what have been considered as variations in the species *productus*. (See p. 600.)

The National Museum collection includes the following lots of this species, all obtained from the same fish and quite constant in their specific characters: Two lots, numbered 6035, obtained by Mr. Rathbun at Woods Hole; one lot, numbered 1307, taken by Vinal N. Edwards at Woods Hole; five lots, numbered W 50, W 51, W 52, W 53, W 54, obtained by Mr. Rathbun in Vineyard Sound, in the immediate vicinity of Woods Hole; five lots, numbered W 55, W 56, W 57, W 58, W 59, obtained by the author from Woods Hole and vicinity. The specimens in Mr. Rathbun's collections number nearly 200, while the author obtained almost as many. The species must therefore be regarded as a very common one on the single fish which it frequents.

CALIGUS PELAMYDIS Kröyer.

Plate XIII, figs. 154–161, Plate XIV, fig. 161a.

Caligus pelamydis KRÖYER, 1863, p. 50, pl. iv, fig. 4, a–g.—RICHIARDI, 1880, p. 148.—CARUS, 1885, p. 357.—BASSETT-SMITH, 1899, p. 452.—BRIAN, 1899, p. 2.

Female.—Carapace orbicular, somewhat narrowed anteriorly, the same width and length, which is much less than half the entire length of the body, and with nearly straight lateral margins (fig. 154).

Frontal plates narrow, a little more than half as wide as the carapace; lunules large, circular, but almost entirely concealed in dorsal view, appearing only as a slight concavity at the base of the first antennæ. Posterior sinuses broadly triangular, the median lobe considerably less than half the entire width. Thoracic area rather small, not quite reaching the center of the carapace. Digestive glands situated at about the center of this area, each in the form of a large right-angled triangle, the perpendiculars parallel with the longitudinal axis, the bases at the posterior ends.

Free thorax segment narrow and short, swollen considerably at the center where the fourth legs are attached. Genital segment broad acorn shape, narrowed into a slender neck where it joins the free segment and squarely truncate posteriorly.

It is two-thirds as wide as the carapace and the sides and posterior corners are symmetrically rounded.

Abdomen as long as the carapace, the length three and a quarter times the width, slightly swollen at the center and constricted where it joins the genital segment. It is two-jointed, the first joint being four times the length of the second.

In living specimens and in material preserved in formalin the joints are distinct, but in material preserved in alcohol they become indistinct. But in all specimens alike the abdomen is abruptly narrowed at the groove between the joints, the terminal joint being considerably narrower than the basal, and tapering posteriorly. Anal laminae of medium size, and flattened, with the tips turned in toward each other.

Egg strings wide, considerably shorter than the body, each containing about thirty eggs.

First antennæ small, the basal joint short and not very wide, but heavily armed with setæ; the terminal joint short, club-shaped, and scarcely projecting beyond the edge of the carapace.

Second antennæ with a very long and slender terminal claw, and without any accessory spine at the base.

First maxillæ very small with a narrow, blunt tip and a slightly swollen base. Second maxillæ long and acuminate, projecting some distance beyond the tip of the rostrum.

Second maxillipeds with a stout basal joint, somewhat swollen, and a much shorter and rather slender terminal claw.

Furca short, the base not more than half as wide as the branches; the latter simple, short, very wide, and curved.

The first natatories have a long plumose seta on the distal end of the basal joint, a short curved claw at the distal end of the second joint, while the terminal joint carries three very large plumose setæ on the posterior margin, and the usual terminal claws. The latter are all curved, about the same size, and close together. In addition there is a finger-like projection extending from the distal margin in the same

direction as the claws. It is of about the same diameter as the claws, but considerably longer and carries at its tip a small curved spine.

The rami of the third legs are some distance apart, but as the exopods are closely appressed to the margin of the basal apron, this brings their tips close to the bases of the endopods.

The spines on the exopods of these legs are proportionally larger than usual and parallel with the outer margin.

The fourth legs are short and stout, and made up of four joints; the basal joint is as long as the remaining three. Of these latter the second is the longest and the fourth the shortest.

The latter joint is triangular and so arranged that the three spines which it bears and the two upon the distal ends of the second and third joints are close together along the outer margin. These spines are all the same size and each has a row of hairs along its outer margin. The fifth legs are very minute and situated on the ventral surface just at the base of the egg cases.

Total length, 3.3 mm. Length of carapace, 1.1 mm.; width of same, 1.1 mm.; length of genital segment, 0.9 mm.; length of abdomen, 1.2 mm.; length of egg strings, 2 mm. Number of eggs in each, 30.

Color, a uniform yellowish white, lighter on the genital segment, which is almost pure white.

(*pelamydis*, the name of its host.)

In his monograph, published in 1863, Kröyer described (p. 50) two small females of this species which had been found on the common bonito (*Gymnosarda pelamis*). His description differs in a few particulars from that here given, the most noticeable one being the presence of double papillæ at the posterior corner representing the fifth legs. In the present specimens also the carapace and genital segment are more nearly the same size, but otherwise the two lots are identical.

It would certainly not be feasible to have two species, both from the same host, and resembling each other so closely. The differences, therefore, must be regarded as mere variations, found in many other species also. Richiardi (1880) reports this species from the gill cavity of the mackerel (*Scomber scombrus*), while Bassett-Smith describes (1896) a species which he calls *C. scomberi* from the gills of the same fish. Again in 1901 T. Scott described and figured a *C. scomberi*, in this case a single specimen adhering to the inside of the gill cover of a mackerel.

Bassett-Smith's description is so meager as to be worthless for identification; in his figures the carapace is long and narrow and the fourth legs have only three joints. But he has placed five spines in a row upon the outer margin of the last joint and none on the second joint. If this were the correct distribution it would be an anomaly indeed, unlike anything known in other species. Scott does not describe the species at all, but in the figure he has given the fourth legs are four-

jointed and two of the five spines belong to the second and third joints, respectively. The carapace also is almost exactly as here figured, and the furca differs only in having the base a little longer. Both Scott and Bassett-Smith figure the abdomen as one-jointed, but neither of them makes any statement in regard to it. In both figures, however, the abdomen narrows abruptly near the posterior end at exactly the place where the joint occurs in the present species.

Bassett-Smith makes no statement of the dimensions of the specimens he obtained, but in his explanation of the plate the magnification of the figure is given as 6. This would give a length of 7 mm. Scott states that the single specimen he obtained was 5.5 mm. In the present species no specimen thus far obtained has exceeded 4 mm.

In view of these meager and conflicting descriptions, together with the contradictions expressed in the figures, it becomes practically impossible to decide just how many species are represented. The size given for *C. scomberi*^a seems to preclude its identity with *pelamydis*, and yet the two agree in almost every detail as given by the one or the other of the two authors quoted.

It will require a careful comparison of the original types to decide the problem finally.

CALIGUS PRODUCTUS Dana.

Plate XIV, figs. 162-170.

Caligus productus DANA, 1854, p. 1354, pl. xciv, fig. 4.—STEENSTRUP and LÜTKEN, 1861, p. 357, pl. III, fig. 6.—KRÖYER, 1863, p. 64, pl. III, fig. 4, a-i.—RATHBUN, 1884, p. 487.—BRIAN, 1898, p. 10.

Female.—Carapace ovate, much less than half the entire length; as long as wide, narrowed anteriorly. Frontal plates projecting strongly, but not more than three-eighths of the width of the carapace. Lunules small, orbicular, scarcely projecting. Posterior sinuses inclined outward, and of medium width, leaving a median lobe less than half the width of the carapace, and not projecting posteriorly. Lateral lobes broad, well rounded, and turned inward slightly at the tips. Thoracic area small, and contracted anteriorly. Eyes small, and placed well back from the anterior margin.

Free thoracic segment very narrow and spindle-shaped, about one-fourth the width of the carapace, and contracted into a neck anteriorly where it joins the latter. Genital segment elliptical, with evenly curved sides, like the free segment contracted anteriorly where it joins that segment, and expanding abruptly to its full width. It is five-eighths as wide, and almost seven-eighths as long as the carapace.

Abdomen elongate linear, somewhat swollen at the center, about one-quarter longer than the genital segment, and more than four times as

^aThis is Bassett-Smith's spelling; Scott changes it to *scomberi*.

long as wide, apparently unsegmented. From a study of the figures given by Kröyer and Steenstrup and Lütken, and from comparison with the developmental history of *C. bonito* it would seem reasonably certain that in the present species there is a similar development. In immature females the abdomen is plainly two-jointed, the joints being fairly equal, but as development proceeds the terminal joint increases faster than the basal. Hence, in mature females the abdomen is probably two-jointed, with the basal joint only one-third or one-fourth of the terminal. Anal laminae small, foliaceous, and curved in toward each other. The plumose setae, with which they are armed, are rather small. Egg cases narrow and reaching only to the tips of these setae, each containing about thirty eggs.

Anterior antennae with a short, stout basal joint and a very slender terminal joint of about the same length, the whole appendage less than the space between the lunules.

Second antennae with a stout basal joint bearing a short and blunt accessory spine on its posterior border.

First maxillae small and strongly curved; second maxillae narrow triangular with acuminate tips, twice as long as wide and straight.

First maxillipeds slender and of the usual form; second pair large and stout, the basal joint much swollen, the terminal claw small. The claw is scarcely half the length of the basal joint, but is stout and well curved.

Furca slender, the basal portion narrower and shorter than the branches, almost circular in outline, and connected with the branches by a narrow neck. The branches are divergent, rather slender, and blunt.

First swimming legs with the usual armament of three terminal claws graded in size, a long slender plumose seta at the distal corner beside the smallest claw, and three rather small plumose setae on the posterior margin. The spines on the exopods of the second legs are very long and acuminate; the two on the two basal joints are inclined at an angle of about 45 degrees with the anterior margin, while the one on the terminal joint is nearly parallel with that margin.

The rami of the third legs are well separated, but the two terminal joints of the exopod are turned in and appressed close to the margin of the basal apron. And they reach so far across the intervening space between endopod and exopod that the two rami appear close together. The spine on the basal joint of the exopod is long, slender, and curved into a sickle shape.

The fourth legs are of medium size, but rather short and three-jointed, with only four spines, one at the distal end of the second joint, one on the outer margin, and two at the end of the terminal joint. The last three are almost in a row, the outer one being but a little behind the others. All these spines are very long and acuminate;

the two terminal ones are serrate along their outer margins. Fifth legs invisible.

Total length 6 mm. Length of carapace 2.1 mm.; breadth of same 2 mm.; length of genital segment 1.6 mm.; length of abdomen 2 mm.; length of egg strings 2.2 mm.; 30 eggs in each.

Male.—Carapace ovate like that of the female, but narrowed rather more anteriorly, as long as wide; median lobe relatively wider and not projecting backward as far. Free segment shorter and relatively wider. Thoracic area wider than long and evenly rounded in front; lateral lobes narrow and somewhat pointed. Genital segment narrow-ovate, one-third longer than wide, the sides nearly straight.

This segment is much smaller than in the female, being less than one-third the width of the carapace and not very much wider than the abdomen. The fifth legs can not be seen in a dorsal view, and there are no traces of lobes at the posterior corners.

The abdomen is elongate-linear, similar to that of the female, and is made up of two distinct joints, which are about equal in length if we leave out of account the anal laminae. The latter are small, scarcely any larger than in the female, but the setae with which they are armed are considerably larger and longer than those of the female.

The appendages are as already described; there is the usual increase in size of the second antennae and the second maxillipeds. And there is the same absence of plumose setae on the posterior border of the terminal joint of the first swimming legs, which may be taken as characteristic of the species.

The fourth legs are small and hardly reach the posterior border of the genital segment. In other particulars the appendages are like those of the female.

Total length 4.5 mm. Length of carapace 2.2 mm.; breadth of same 2.2 mm.; length of genital segment 1.1 mm.; length of abdomen 1.1 mm.

Color a uniform yellowish brown entirely destitute of pigment markings of any sort.

(*productus*, lengthened or drawn out.)

There is one lot of this species in the National Museum collection, consisting of four females taken from the common dolphin (*Coryphæna hippurus*), from the inner side of the gill covers and the outer surface of the body. The fish was captured by the United States Bureau of Fisheries steamer *Albatross* in latitude 38, 19, 26 West and longitude 68, 20, 20 North. This is the original species described by Dana in 1854 as occurring on the same dolphin and on trigger fishes (*Balistes*) in the West Indies. It was afterwards noted by Steenstrup and Lütken (1861) as taken from the inside of the operculum of the “*Barracuda*” (*Sphyræna*), and by Krøyer (1863) as found on this same *Coryphæna*.

The specimens described by these three authors agree closely in

general details, but differ in several particulars, as also do the specimens here described. The greatest differences are found in the furca, the first and fourth swimming legs, the abdomen, and the egg strings. In Dana's original species the branches of the furca are longer and more strongly curved, while in the present specimens the base of the furca is larger and the branches are short, straight, and strongly divergent.

All the authors unite in characterizing the species by a complete absence of the setae on the posterior border of the first swimming legs. In the present specimens they are certainly present, but are unusually small.

Dana's species shows the fourth legs three-jointed, with five spines, all about the same length; in the present specimens there are but four spines, and the inner terminal one is twice the size of the others. All the authors write that the abdomen is obscurely two-jointed, but Krøyer figures the adult female with an apparently one-jointed abdomen, as in the figures herewith presented. Dana states that the egg strings are "longer than the body" (p. 1354); Steenstrup and Lütken figure them as only half the length of the body, but as twice the length of the abdomen, with eggs so large that each tube could contain only twenty.

In the present specimens the egg tubes are but a trifle longer than the abdomen (one-third the entire length), but each contains 40 eggs.

In view of such differences it might seem as if the present specimens constituted a new species, but after careful consideration this does not seem to be warranted. In the first place, they come from the same host as those obtained by the authors mentioned; a good presumption in favor of their identity.

Again, both Krøyer and Steenstrup and Lütken found great differences in their specimens, and they each figure what they call a variety of the species fully as different from the type as the present specimens. Nor do the egg tubes here shown differ any more from those given by the authorities just quoted than the latter do among themselves. For this reason these specimens have been referred to Dana's species, and possibly the males reported by Brian (1898) may belong here also.

The foregoing are all the species of *Caligus* from North American localities which are contained in the collection of the National Museum. But in addition the following species have been reported from the West Indies by various authors. The types of these species have been lost or are contained in foreign museums. In most instances the species are represented by very few specimens, sometimes only one or two, obtained many years ago, and none have since been found, but this is chiefly, if not wholly, due to the fact that no investigations have been made in that region since these specimens were found; and there is every reason to believe that a careful search at the pres-

ent day would yield some of the same species, as well as many new ones.

The diagnoses of these species and the outline drawings presented with them are taken from the original descriptions as far as possible, and in one or two instances additions have been made from later authors, for which acknowledgment is duly made. Dana's species, *C. thymni*, was obtained a long distance from the American shore, but as it was found upon the same bonito which serves as host of three other species here described, it is likely to be found here at any time; and then it is really needed for purposes of comparison, and so is here included.

CALIGUS BALISTÆ Steenstrup and Lütken.

Plate XV, figs. 172-177.

Caligus balistæ STEENSTRUP and LÜTKEN, 1861, p. 356, pl. I, fig. 1.—BASSETT-SMITH, 1899, p. 448.

Female.—Carapace elliptical, as wide anteriorly as posteriorly, more than half the entire length. Frontal plates not prominent nor very distinct; lunules small and widely separated. Posterior sinuses shallow and nearly parallel with the longitudinal axis; median lobe about half the entire width and shorter than the lateral lobes; the latter are narrow and somewhat pointed.

Free segment very narrow and long, like a wasp waist, and not much widened at the center through the bases of the fourth legs. Genital segment obovate, well rounded anteriorly, but with a deeply concave posterior margin, leaving the lobes at the external angles short and acute.

Abdomen short and wide, only half the length of the genital segment and somewhat club-shaped; anal laminae minute and armed with small setae. Egg strings about the same width as the abdomen and as long as the entire body; eggs large and well rounded, about fifty in each string.

First antennae longer and more thickly beset with setae than usual, those at the extremity of the terminal joint being very long. Second antennae rather weak. Second maxillipeds with a stout basal joint and a slender terminal claw, the accessory spine of the latter being much nearer the tip than usual. Second maxillae slender, curved and acuminate. Furca small, base wide and short, branches very slender, straight, and divergent, about twice as long as the base. Fourth legs three-jointed, with four spines; the latter slender and very long, all four about the same length; fifth legs invisible dorsally. Total length 4.5 mm. Length of carapace 2.6 mm.; width of same 2.2 mm.; length of genital segment 1.4 mm.; length of abdomen 0.6 mm.; length of egg strings 4.6 mm.

Male.—Carapace proportionally very large, twice as long and three times as wide as the rest of the body, slightly narrowed anteriorly; frontal plates small and narrow; free segment even smaller relatively than in the female, which is very unusual; genital segment semilunar in shape, nearly twice the width of the abdomen, with very long and acuminate lobes at the posterior corners. Two pairs of setiferous papillæ, one at the tips of the lobes and the other on the inner margins near the base.

Abdomen the same length as the genital segment and slightly swollen near the tip; appendages as in the female, with the usual increase in the size of the second antennæ and second maxillipeds; fourth legs proportionally longer and more slender than in the female.

Total length 4 mm.; length of carapace 2.68 mm.; width of same 2.35 mm.; length of genital segment 0.8 mm.; length of abdomen 0.79 mm.

Color not given.

(*balistæ*, generic name of host.)

Several examples of this species were obtained from the gills and fins of West Indian species of the genus *Balistes*.

A few individuals in the chalimus stage were also found still fastened by a frontal filament.

CALIGUS ISONYX Steenstrup and Lütken.

Plate XIV, fig. 171; Plate XV, figs. 184-186.

Caligus isonyx STEENSTRUP and LÜTKEN, 1861, p. 358, pl. III, fig. 5.—BASSETT-SMITH, 1899, p. 450.

Female.—Carapace considerably less than half the entire length, as wide as long, narrowed anteriorly; frontal plates not prominent; lunules very small; antennæ short; posterior sinuses comparatively deep, with parallel sides; median lobe scarcely one-third the entire width, its posterior margin just even with those of the lateral lobes; free segment narrow, but long and not swollen much at the center; genital segment acorn-shaped, narrowed into a slender neck, where it joins the free segment, the sides symmetrically rounded, the posterior margin squarely truncated. There are two pairs of rudimentary leg papillæ on this segment, one on the lateral margins considerably posterior to the center of the segment, the other at the posterior corners. Abdomen two-thirds the length of the genital segment, quite wide, and enlarged a little toward the tip; anal laminae terminal, very small, and carrying small setæ; egg strings unknown. Frontal plates emarginate between the lunules; basal joint of first antennæ short; terminal joint much longer, but scarcely protruding beyond the margin of the carapace.

Second antennæ long and slender, with an elongated and narrow terminal claw, strongly curved.

First maxillæ short and strongly curved, the base only slightly enlarged; second pair longer than the proboscis, straight and acuminate, with a small tooth on the inner margin near the center.

Terminal claw on the second maxillipeds bent nearly into a semi-circle. Furca short and wide, the branches longer than the base, straight and divergent. Claws at the tip of the first swimming legs moderately long, and all, together with the seta at the distal corner, the same length. Branches of the second legs longer than usual, the exopod with long and pointed spines. Rami of the third legs large and close together, the spine at the base of the exopod large and strongly curved. Fourth legs four-jointed, with five spines, all slightly curved, the one at the tip of the second joint longer and curved more than the others, the rest about equal.

Total length 4.5 mm. Length of carapace 2 mm.; width of same 1.9 mm.; length of genital segment 1.4 mm.; length of abdomen 0.9 mm.

Color not given.

(*isonyx*, ἰσός, equal and ὄνυξ, a claw.)

This species is based on a single example, which is evidently a female although it lacks the egg strings. It was taken from the gills of the great barracuda, *Sphyræna barracuda* (Walbaum), in the West Indies.

CALIGUS THYMNI Dana.

Plate XV, figs. 178, 179.

Caligus thymni DANA, 1852, p. 56.—DANA, 1852, p. 1353, pl. XCIV, fig. 3, a-c.—T. SCOTT, 1894, p. 129, pl. XIV, fig. 21.—BASSETT-SMITH, 1899, p. 451.

Female.—Carapace oblong, not narrowed anteriorly, the length one and a half times the width. No emargination at the center of the frontal plates; lunules elliptical and not prominent. A short seta on the frontal margin on either side about half way between the lunule and the center. Eyes deep red on a black background. Free segment short and wide. Genital segment oblong, the sides divergent, widest posteriorly, where it is about twice the width of the abdomen; posterior angles prominent and tipped with setæ. Abdomen longer than the genital segment, two-jointed, with the basal joint about half the length of the terminal; anus prominent.

Anal laminae small, filling out the posterior angles and hardly projecting beyond the anus. The three plumose setæ which they carry are as long as the last joint of the abdomen, and do not diverge, as is many species, but are parallel.

Egg tubes a little narrower than the abdomen, longer than the entire body, each containing 40 eggs.

First antennæ small, terminal joint very slender and tipped with setæ as long as the joint itself. Second antennæ of moderate size with a

slender terminal claw but with no spine on the posterior margin of the basal joint.

First maxillæ lacking; second pair stout and broad. First maxillipeds with basal joint about three fourths the length of the terminal; second pair very stout, basal joint subconical in shape, without protuberances, the terminal claw less than half the length of the basal joint. Furca simple, the branches divergent, straight and acuminate. Fourth legs three-jointed with four simple spines, no teeth on the spines nor sheathing setæ at their bases.

Total length 9.7 mm. Length of carapace 4.9 mm.; width of same 3.4 mm.

Color not given.

(*thymni*, the generic name of its host.)

Male.—Carapace elliptical, about one-eighth longer than wide, not narrowed much anteriorly. Frontal plates small, without an emargination at the center and very narrow; lunules small and semicircular. Free segment like that of the female. Genital segment nearly quadrate, the sides somewhat convex, the posterior margin almost squarely truncate, with the posterior angles scarcely projecting at all, but each armed with a bunch of setæ representing the fifth leg of that side.

Abdomen a little shorter than the genital segment, almost as wide as long, two-jointed, the basal joint only about half the terminal as in the female. Anal laminae as before, but the plumose setæ much longer, as long as the entire abdomen.

The appendages show the usual increase in the size of the second antennæ and second maxillipeds. The former have a stout branch on the inner margin of the terminal joint near its center. The fourth legs are longer and more slender than those of the female, and the spines which they carry are longer and weaker.

This species was obtained from the oceanic bonito (*Gymnosarda pelamis* Linnaeus; *Thynnus pelamys* Cuvier and Valenciennes), and is the fourth species of *Caligus* to be recorded from that host. The other three species are *pelamydis*, *productus*, and *bonito*. It will be instructive to review here the distinguishing characters of these four species.

They differ, first, in size, and may be arranged in an ascending series, *pelamydis*, 3–4 mm. long; *productus*, 5–6.5 mm.; *bonito*, 7–8 mm., and *thymni*, 9–10 mm.

Again, they differ considerably in color, although unfortunately the color of *thymni* has never been given. *Pelamydis* is a light yellowish white, the genital segment almost pure white without pigment of any sort. *Productus* is a light dirt-brown, everywhere transparent, except the egg strings; while *bonito* is a very transparent white faintly tinged with yellow, and with a large spot of rusty-brown pigment in the posterior portion of the lateral area on either side, like a large lateral eye.

The genital segment in *pelamydis* is nearly orbicular, only a trifle longer than wide (one-sixteenth), not narrowed into a neck anteriorly and only slightly emarginate posteriorly.

In *productus* and *bonito* this segment is elliptical, narrowed into a very marked neck anteriorly and with stout lobes prolonged far backward posteriorly on either side of the abdomen.

In *thymni* it is trapezoidal, widest posteriorly, with straight sides and short, narrow posterior lobes.

The abdomen is two-jointed in each of the species, but in *pelamydis* the basal joint is three times the length of the terminal and only one-third as wide as the genital segment.

In *bonito* the basal joint is about twice the length of the terminal and the abdomen is two-fifths the width of the genital segment. In *productus* the terminal joint is twice the length of the basal and the abdomen is one-third the width of the genital segment. In *thymni* the terminal joint is also twice the basal, but the abdomen is fully half the width of the genital segment. In the structure of the abdomen, therefore, the species arrange themselves in two pairs, a large and a small species in each pair, which correspond quite closely.

The fourth legs in *pelamydis* are four-jointed with five spines, the last two joints very short and squat, bringing the five spines close together in a row. In *productus* these legs are three-jointed with four spines, the two terminal joints long and slender, the last two spines toothed along their outer margins. In *bonito* the legs are of medium length, three-jointed with five spines, none of which are toothed. In *thymni* they are long and slender, four-jointed with five spines, none of which are toothed. All the authors who have hitherto noticed *productus* are agreed that the first swimming legs have no plumose setæ on the posterior border of the terminal joint.

The male of *pelamydis* is unknown, but in the males of the other three species there is even greater differences than in the females. In *productus* the free segment of the male is a little narrower than the genital segment, and the fourth legs do not reach its posterior margin. The terminal joint of the abdomen is half as long again as the basal and the anal papillæ are small. In the male *bonito* the free segment is a little wider than the genital segment and the fourth legs reach considerably beyond its posterior margin. The two abdomen joints are about equal and the anal laminæ are very large.

In *thymni* the free segment is about half the width of the genital segment and the fourth legs just reach its posterior margin. The abdomen is as wide as it is long with the terminal joint nearly twice the length of the basal. These four species are thus well distinguished in both sexes, but more clearly in the males, since there is not as much specific variation in this sex.

CALIGUS HÆMULONIS Krøyer.

Plate XV, figs. 180-183.

Caligus hæmulonis KRØYER, 1863, p. 48, pl. iv, fig. 3, a-d.—BASSETT-SMITH, 1899, p. 448.

Female.—Carapace not quite half the entire length (as 9 to 20), as wide as long. Frontal plates projecting very strongly between the lunules, with a deep median incision. Lunules themselves large, elliptical and widely separated. Posterior sinuses wide and shallow; median lobe a little more than half the entire width, and projecting but little behind the lateral lobes; the latter broad and well rounded. Cephalic area very much larger than the thoracic; eyes over the base of the proboscis and elliptical. Free segment very narrow and short, standing out in sharp contrast with both carapace and genital segment.

Genital segment orbicular or slightly obcordate, a little wider than long with a shallow posterior emargination. It is one-third shorter than the carapace with symmetrically rounded sides and posterior corners.

Abdomen a little more than half as long as the genital segment and one-third as wide, contracted at its base and unsegmented; anal papillæ small with short setæ; egg strings unknown.

First antennæ small, the joints equal in length; second pair situated so near the posterior border of the lunules as to partially hide them. First maxillæ stout and sickle-shaped; second pair a little shorter than the proboscis, situated far forward on either side of the latter and just reaching its tip.

They are simple, somewhat weak, acuminate and slightly curved. Maxillipeds of the usual form; furca large, base as long as the branches, with parallel sides and an oval foramen; branches stout, acuminate, curved, divergent, the space between them having a width equal to its length. First swimming legs short and thick, the terminal spines all the same length, while the plumose setæ on the posterior border of the terminal joint are entirely lacking. Rami of third legs widely separated, the outer branch long and stout. Fourth legs three-jointed, the basal joint as long as both the others, minus the claws; second and third joints the same length; claws quite close together.

Total length 2.8 mm. Length of carapace 1.35 mm.; width of the same 1.3 mm.; length of genital segment 0.75 mm.; length of abdomen 0.6 mm.

No statement with regard to the color or habits.

Male.—Carapace slightly more than half the entire length; frontal plates distinct, not projecting as in the female, but about as deeply incised at the center. Lunules large and more nearly circular. Posterior sinuses even more shallow than in the female; median lobe con-

siderably more than half the entire width and quite squarely truncate posteriorly.

Free segment five-sevenths as wide as the genital segment, and much swollen at the center through the bases of the fourth legs.

Genital segment ovate, three-sevenths as long as the carapace, with evenly rounded sides; fifth legs not visible dorsally.

Abdomen a little shorter than the genital segment, two-jointed, the terminal joint three times as long as the basal; the latter considerably wider than long; anal papillæ as in the female, but the plumose setæ much longer.

Total length 2.25 mm. Length of carapace 1.25 mm.; width of same 1.2 mm.; length of genital segment 0.6 mm.; length of abdomen 0.5 mm.

Three specimens, two females and a male, of this well-defined species were obtained from the gills of *Hæmulon elegans* Cuvier, in the Danish West Indies. The largest female was full size, with egg strings just hatched.

(*hæmulonis*, generic name of the host.)

CALIGUS MONACANTHI Krøyer.

Caligus monacanthi KRÖYER, 1863, p. 59, pl. III, fig. 2, a-e.—BASSETT-SMITH, 1899; p. 450.

Krøyer obtained what he states to be a male *Caligus* from the skin of a *Monacanthus* in the West Indies. There was but the single specimen on which to found this new species.

After a careful examination of Krøyer's figures and a study of his description, it seems to the author that he must have mistaken the sex of his specimen, and that what he really had was a young female *Caligus productus*.

The general make-up of the creature is that of a female and not a male; the genital segment is very large for a male, and if it were really that sex with lobes at the posterior corners, as indicated, the setæ of the fifth legs would certainly be visible.

But Krøyer states that there are no setæ. Again, if it were a male, with an abdomen as long as indicated, that region would certainly be segmented as in all other known species.

In the description Krøyer does not notice any differences in the second antennæ and second maxillæ, which are characteristic of all males. On the other hand, his description is identical throughout with that given for the female of *productus*, and we note particularly the absence of plumose setæ on the terminal joint of the first swimming legs, the group of seven or eight pectinate projections on the outer border of the basal joint of the endopod of the second legs, the widely separated rami of the third legs, while the fourth legs are three-jointed, with four spines, the inner terminal one much longer than the others. In

view of the marked similarity between this single specimen and the female *productus*, it will at least be necessary to wait for further specimens whose sex can be established beyond a doubt before admitting it as a new species.

This completes the North American species so far as known at the present time, but there are in the National Museum collection, specimens of another species from South America which seem to be new to science and whose description is here included. (See p. 649.)

Genus CALIGODES Heller.

Carapace minute, a very small fraction of the entire length. Frontal plates well defined and furnished with lunules. First maxillæ small with a swollen base; second maxillæ simple. Furca large and prominent with the divergent and sharp-pointed branches bent so as to appear like a grapnel anchor in side view. Free segment narrow and somewhat elongated, forming a neck connecting the carapace with the genital segment.

First and fourth legs uniramous, second and third biramous, the fourth pair sometimes partially rudimentary.

Genital segment much swollen and prolonged posteriorly into two processes as long as the abdomen and extending backward nearly parallel with it on either side. Fifth legs lacking.

Abdomen elongate and flattened; anal laminae linear and minute.

Egg cases long and narrow; eggs as in *Caligus*.

(*Caligodes*, *Caligus*, and *odes*, a termination denoting likeness or similarity.)

This genus will be distinguished from *Echetus* under the latter genus (see p. 615), and it only remains to separate it here from van Beneden's genus, *Sciænophilus*. In the latter the free thorax segment is very short and wider than long, as it is in *Caligus*, while in the present genus the free segment is much elongated. Again in *Sciænophilus* the genital segment is without processes or appendages, while here it is prolonged on either side into an appendage as long and as large as the abdomen. In *Sciænophilus*, also, the second maxillipeds are very large and massive, while here they are of moderate size.

ANALYSIS OF SPECIES.

1. Abdomen wide and produced into posterior lobes; fourth legs four-jointed with five spines.....*carangis* (B-Smith, 1898, b).
1. Abdomen without lobes or processes, of medium width..... 2.
 2. Processes on genital segment longer than the abdomen; fourth legs inserted close to the carapace, two-jointed with two spines.
megacephalus, new species.
 2. Processes on genital segment shorter than the abdomen; fourth legs inserted some distance back of the carapace, three-jointed with one small spine.
laciniatus (Kröyer, 1863).

CALIGODES MEGACEPHALUS, new species.

Plate XVI.

Female.—Carapace orbicular, a little longer than wide nearly one-fourth the entire length. Frontal plates distinct and furnished with small lunules, which are better developed than those on *Echetus*. Frontal margin deeply incised at the center, with the remains of the basal portion of an attachment filament still left in the incision. In this genus, therefore, the development is similar to that of *Caligus*, and the larva at one period is attached by means of a frontal filament.

Posterior sinuses small, narrow, and inclined toward the central axis; median lobe but little more than one-third of the entire width, projecting half its length back of the lateral lobes. The latter are rather pointed and curved inward at the tips. Thoracic area small, half the width and a third of the length of the carapace. Eyes small and situated far forward. Free segment elongate, a little more than half the length and one-third the width of the carapace, contracted where it joins the latter, but widened through the bases of the fourth legs (fig. 187).

Genital segment also elongate, flask-shaped, produced into a long neck anteriorly, while at the posterior end it extends backward in a narrow lobe on either side of and nearly as long as the abdomen. On the dorsal surface of this segment there is a broad horseshoe-shaped curve, the toe of the shoe formed by a slight projection just over the anus, while the sides of the shoe extend forward in a curve parallel with the margin of the segment. Abdomen elongate, nearly as long as the genital segment, only one-fifth as wide as long, and the same diameter throughout, except at the very tip. It shows no trace of segmentation. The anal papillæ are very minute and inclined toward each other. The egg cases are narrow, while the eggs are thick and probably not very numerous, although that can not be decided with certainty, since the cases are broken and the posterior portion is lacking.

Of the ventral appendages the anterior antennæ are as long as the frontal plates, the terminal joint longer than the basal, and both armed with setæ in the usual manner.

Posterior antennæ with a short basal joint and a long terminal claw bent into a sickle shape. There is a short and blunt accessory spine at the base of the first joint.

The first maxillæ are little more than a swelling on the ventral surface of the carapace. The second maxillæ are broad and triangular, and as long as the mouth tube. They are removed some little distance from this tube on either side and are rather blunt at the tip.

The first maxillipeds are short and stout, the joints approximately even, the terminal claws short. The second maxillipeds are large and

strong, the terminal claw three-fourths as long as the swollen basal joint, with a large tooth on its inner margin near the base. Furca small, the base about the same length as the branches. The latter are slender, well separated, and nearly parallel. This furca is reenforced on either side by a stout curved spine, situated about halfway between the furca and the bases of the first legs and a little distance from the mid line.

First legs short and stout, the last joint bearing a single short terminal spine, not curved, and the usual three plumose setæ on its posterior border. There are no terminal claws.

The second legs are like those of *Caligus* in segmentation and appendages, with the spines on the three joints of the exopod the same size and rather small. Rami of the third legs close together, each two-jointed and furnished with the usual setæ and fringe of hairs. Fourth legs two-jointed, the joints the same size and length, the second one terminating in a single spine of medium size. Fifth legs entirely lacking.

Total length, 6.1 mm. Length of carapace, 1.25 mm.; width of same, 1.1 mm.; length of genital segment, 2 mm. (4 mm. including the posterior processes); length of abdomen, 2.2 mm.; length of free segment, 0.7 mm.

Color a dark yellowish brown, abdomen and egg strings darker than the rest of the body.

(*megacephalus*, μέγας large and κεφαλή head.)

There is but a single female of this species in the National Museum collection, numbered 6103 which was taken from the underside of the mouth of a silver gar (*Lepisosteus osseus*) at Woods Hole. It has apparently shrunk somewhat in the preservative, but as the shrinkage has been uniform it has not affected the proportions of the different parts.

This is of importance, because the details of the appendages in the two species of this genus already described are meager, especially for the species *luciniatus*, the type. Hence the distinction of species must be based upon the relation of the different parts. This will appear to better advantage in tabular form.

Measurements.	<i>Laciniatus.</i>	<i>Carangis.</i>	<i>Megacephalus.</i>
	mm.	mm.	mm.
Total length.....	5-5.5	11-12	6.1
Length of carapace.....	.75	1.6	1.25
Length of free segment.....	1.3	.2	.7
Length of genital segment.....	2.9	6.3	4
Width of carapace.....	.8	1.7	1.1
Width of genital segment.....	1.7	1.5	1.5

From this table it can be seen that the species *carangis* is about twice the length of the other two, which are themselves approximately equal. But the carapace in *carangis* is only one-seventh the entire length, while in *megacephalus* it is a quarter. The free segment in *megacephalus* is actually three and a half times as long as in *carangis*, or proportionately seven times the length, and yet it is only half as long as the free segment in *laciniatus*. The relative width of the genital segment and carapace also vary greatly in the three species.

And if Kröyer's figure of the ventral surface of *laciniatus* is to be trusted for details of the appendages, the second maxillipeds in that species have no tooth at the base of the terminal claw, and there are no accessory spines in connection with the furca.

Genus ECHETUS Kröyer.

Carapace minute, a very small portion of the entire length; frontal plates well defined and furnished with lunules. First maxillæ and furca lacking; second maxillæ simple.

Free thoracic segment very narrow and much elongated, forming a long neck connecting the carapace and the genital segment.

First and fourth legs uniramous, the fourth pair partially rudimentary; second and third pairs biramous. Genital segment swollen several times the size of the carapace, without appendages or processes. Abdomen an elongate spindle attached to the genital segment by a very short and narrow neck; anal laminae linear, minute. Egg cases a little longer than the abdomen, eggs as in *Caligus*.

(*Echetus*, the name of a king mentioned in Odyssey, line 85.)

“εἰς Ἐχետὸν βασιλῆα, βροτῶν δηλῆμονα πάντων.”

This name is peculiarly appropriate, as can be seen from a translation of the context, “And I shall send you to King Echetus, destroyer of all men, who will cut off your nose and ears with pitiless steel, and draw out your vitals and give them to dogs to eat raw.”

Only one species known.

ECHETUS TYPICUS Kröyer.

Plate XVII.

Female.—Carapace about one-twentieth the entire length, longer than wide. Frontal plates well defined and furnished with small lunules, which are widely separated and not fully visible dorsally. The median incision between the two plates is as deep as the plates themselves, reaching the margin of the cephalic area. In this incision can be plainly seen the remains of the base of an attachment filament similar to those in *Caligus*.

This indicates plainly that the genus has a development similar to that of the other members of this subfamily.

Posterior sinuses shallow with divergent sides; median lobe four-sevenths the entire width, projecting far behind the lateral lobes, with nearly straight, inclined sides, and an emarginate posterior border. Lateral lobes short and well rounded. Thoracic area very small, the groove which defines its anterior border reaching only a short distance in front of the posterior sinuses, or about one-third the entire length of the carapace.

The longitudinal grooves separating the lateral from the cephalic areas are not well defined and are consequently difficult to trace. Eyes small and situated well forward.

Free thoracic segment cylindrical, about one-fourth the width of the carapace, contracted considerably just before joining the latter and prolonged posteriorly into a narrow, thread-like neck, nearly twice the length of the rest of the body.

The fourth legs are attached close to the carapace just back of the constriction.

Genital segment approximately an ellipsoid, two and a half times as long and twice as wide as the carapace. It is flattened somewhat dorso-ventrally and has three lobes on the posterior margin, a short blunt one at the base of each of the egg cases and a smaller median one. The dorsal surface of this segment is marked by two ridges which start from the center of the lateral margins on either side and curve in toward each other and pass backward close together alongside the median line to the posterior median lobe. The areas at the posterior end of the segment outside these ridges are darker in color than the rest of the segment, and their surface is wrinkled irregularly. They contain the ovaries and the internal oviduct.

The abdomen is an elongated spindle, nearly twice the length of the genital segment and half its width, unsegmented. It is contracted into a very narrow wasp-waist where it joins the genital segment and tapers evenly and gradually toward the posterior end. It is attached to the ventral surface of the genital segment, a short distance in front of the posterior end, and in a side view stands out nearly at right angles to the longitudinal axis of the segment.

Anal papillæ linear, almost thread-like, but quite long and tipped with three short setæ. Egg tubes narrow, only one-quarter as wide as the abdomen but about the same length, each containing 40 to 50 eggs.

Anterior antennæ the same length as the frontal plates; basal joints thick, conical, and heavily armed with plumose setæ; terminal joints the same length as the basal, cylindrical, and bluntly rounded at the ends where they show the usual nonplumose setæ.

Frontal plates peculiar in that the outer portion between the lunules

and the antennæ curves forward and projects considerably, looking like the stumps of an accessory pair of antennæ.

Posterior antennæ small, with a stout basal joint and a long slender terminal hook, not bent very sharply. They are situated far forward almost at the very anterior margin of the carapace. No trace could be found of the first maxillæ or the furca after the most careful search.

Second maxillæ short and wide, triangular in outline with swollen bases, and bluntly rounded at the tip. They are closely appressed to the side of the mouth tube and are about two-thirds its length. The mouth tube is short and wide, almost a semicircle in outline, and flattened against the ventral surface of the carapace. It does not seem capable of being raised any distance from the latter as in *Caligus* and other genera.

First maxillipeds short and comparatively stout, the two joints about the same length; terminal claws short and stout, the inner one twice as long as the outer. Second maxillipeds greatly enlarged and very strong, evidently serving as the principal organs of attachment to its host. The basal joint is much swollen and furnished with powerful muscles; the terminal claw is two-thirds as long as the basal joint and strongly curved. No accessory spine could be seen upon the specimens examined.

The first thoracic legs are long and narrow, the second joint five times as long as wide and cylindrical. The terminal joint is also much longer than wide, and armed as in *Caligus*, with three terminal claws of moderate length, three plumose setæ on the posterior margin, and a long slender seta at the corner between the two. Second legs large, with a long basal joint and a three-jointed endopod and exopod, the joints of similar size and shape, and armed with spines and plumose setæ, as in *Caligus*. Third legs also large, the rami close together, each two-jointed and furnished with the usual number of plumose setæ. The spine at the base of the exopod is of medium size and acuminate. Outside of the exopod on the margin of the apron is a wide transparent flap, similar to that around the edge of the carapace, and supported by numerous wavy hair-like ribs. Fourth legs short and stout, two-jointed, the joints about equal. The terminal joint carries three terminal spines and one on the outer margin, all nearly the same size. No trace of the fifth legs can be found.

Total length, 23.5 mm. Length of carapace, 1.1 mm.; width of same, 1 mm.; length of free segment, 14 mm.; length of genital segment, 3.1 mm.; length of abdomen, 5.5 mm.; length of egg strings, 6 mm.

Color of the carapace, a light yellowish brown, of the long neck-like free segment a dark brown, of the genital segment a sulphur yellow except in the posterior areas of the dorsal surface outside the ridges, where the yellow is mixed with dark brown; color of the abdo-

men a brownish yellow, considerably darker than the genital segment; of the egg strings a dark brown.

(*typicus*, typical, that is, the type of the genus.)

The National Museum collection includes three unnumbered lots collected by Dr. H. M. Smith from the inside of the operculum of the common channel bass (*Sciaenops ocellatus* Linnaeus) in the fish markets in Washington city.

In 1863 Krøyer published the description of some specimens of female copepods which he had obtained from this same channel bass at New Orleans. He called the fish *Corvina unimaculata* in his manuscript. He states frankly that the parasites had no head and only a portion of the long and slender neck. But they seemed to him so different from any of the others he had examined that he established for them a new genus *Echetus*, and a new species, *typicus*. From his figures and description there is no doubt that his specimens were the same as those here described, especially as they were obtained from the same species of fish. The names which he gave have accordingly been adopted, and the genus designation, which has already been explained (p. 611) seems peculiarly appropriate for a creature which burrows into the flesh of its host the entire length of the carapace and long free segment, leaving nothing but the genital segment and abdomen exposed.

So firm is the hold which the creature thus obtains that it is impossible to remove one entire without cutting away the flesh from around its neck and carapace. Those which Krøyer obtained were probably pulled out without cutting the flesh, with the result that the free segment broke somewhere near the center, to judge by the measurements which he gives. For the obtaining of the head intact upon several of the present specimens the author is deeply indebted to the persistent and careful efforts of Doctor Smith. And the result fully justifies the efforts, for the addition of the head changes entirely the systematic position of the genus and its relationships. Krøyer considered that the portion which he obtained indicated considerable degeneration. He states that "the large knobs on the dorsal surface are, as it were, the beginning of a monstrosity of the genital parts observed in *Lernæ branchialis* and *L. cyclopterina*, and indicates an approximation to those forms." And in accordance with this view he places the species in a group which he designates as *Lernæocerina* (*Lernæidæ*), including the most degenerate forms known. But the general arrangement of the various body regions, together with the details of the carapace and the appendages, show at once that it belongs to the subfamily *Caliginæ* now under consideration. It thus takes its place among the least rather than the most degenerate forms.

It is most closely related to the genus *Caligodes*, founded by Heller in 1865. On comparing it carefully with the three species already

known in that genus, the following differences may be noted. First, the carapace is relatively much smaller here and ovate instead of orbicular. Again, the free segment or neck is nearly twice as long as in *Caligodes*, and it is the same diameter throughout, instead of being enlarged where it joins the genital segment. The latter is also very different, having no processes of any kind in *Echetus*, but simply short and rounded lobes, such as are common in *Caligus* and other genera.

The dorsal surface of this segment is also marked by the ridges already described, in a manner totally unlike *Caligodes*. Here the abdomen is a symmetrical elongated spindle, while in *Caligodes* it is broad and flattened, and in the species *carangis* is produced into posterior processes, like the genital segment. In this genus also the fourth legs are different from those in the three species of *Caligodes*, but the latter differ as much from each other, so that this could hardly become a generic distinction.

Genus LEPEOPHTHEIRUS Nordmann.

Carapace large, shield-shaped. Basal joints of the first antennæ without the sucking discs characteristic of *Caligus*; the terminal joints free. Mandibles toothed only on the inner margins. Second maxillæ small, bifurcate, the branches acuminate.

First and fourth thoracic legs uniramous, second and third biramous. Free thoracic segment simple, without dorsal plates. Genital segment also simple, without plates or processes. Abdomen one or two segmented. The young with a frontal filament during the chalimus stage, as in *Caligus*.

(*Lepeophtheirus*, λεπόδς, a scab, and φθέρ, a louse.)

ARTIFICIAL KEY TO THE SPECIES.

This key is based upon the different body relations, as in *Caligus* (see p. 555). The same method of measurement is used as in the former genus, and here also are included all the valid species known at the present time, with the authority for each. The author considers *L. obscurus* (Baird) to be the male of *L. hippoglossi*, while the specimen called by Bassett-Smith (1896, plate iv, fig. 2) "*Caligus obscurus*, Baird," is certainly not identical with Baird's species, but is probably *L. thompsoni* (see p. 622). Three of Krøyer's "new species," *gibbus*, *gracilescens*, and *rhombi*, are considered identical with *L. thompsoni*, as are also Malm's *L. branchialis* and van Beneden's *L. gracilis*, for reasons stated on page 622. Of the remaining species which are included in this key there are five which are based on single specimens, namely, *cosyphi*, *longipalpus*, *molæ*, *quadratus*, and *robustus*. Another, *ornatus*, was not very clearly differentiated by Milne-Edwards, and no figure of it has ever been published.

- | | |
|----------------------------------------------------------------------|-----|
| 1. Carapace definitely more than half the entire length..... | 2. |
| 1. Carapace about half the entire length | 14. |
| 1. Carapace decidedly less than half the entire length..... | 17. |
| 2. Abdomen two-jointed, half as long as genital segment or more..... | 3. |
| 2. Abdomen two-jointed, less than half the genital segment..... | 4. |
| 2. Abdomen one-jointed, half the genital segment or more..... | 5. |
| 2. Abdomen one-jointed, less than half the genital segment | 10. |

3. Females, genital segment obovate, longer than wide; lobes long, conical; fourth legs long *longipes*, new species, p. 618.
3. Females, genital segment orbicular, a fourth wider than long; lobes short; fourth legs short *chilensis*, new species, p. 658.
4. Males, genital segment obovate, three-fifths the carapace; fifth and sixth legs separated *nordmannii* (M-Edwards, 1840), p. 623.
4. Males, genital segment oblong, one-fourth the carapace; fifth and sixth legs close together *erecsoni* (Thomson, 1890)
5. Males, both fifth and sixth legs showing plainly 6.
5. Males, only fifth legs showing, but with a pair of dorsal papillae at the base of the genital segment 7.
5. Males, only fifth legs showing; no papillae 8.
5. Females, genital segment without appendages of any sort. 9.
6. Genital segment barrel-shaped, sides curved; no lobes; fourth legs reaching its center *pectoralis* (Müller, 1776).
6. Genital segment oblong, sides parallel; well lobed; fourth legs reaching abdomen tip *chilensis*, new species, p. 658.
7. Genital segment obcordate, one-third the carapace; fourth legs reaching its center only *appendiculatus* (Kröyer, 1863).
7. Genital segment quadrate, one-fifth the carapace; fourth legs reaching fully to its tip *robustus* (Kröyer, 1863), p. 646.
7. Genital segment reniform, wider than long; anterior appendages lateral rather than dorsal *crabro* (Kröyer, 1863).
8. Genital segment semilunar, wider than long; fourth legs nearly reaching its tip *rotundiventris* (B-Smith, 1898, b).
8. Genital segment diamond-shaped, longer than wide; lobes short, acute; fourth legs short *bagri* (Dana, 1852).
9. Genital segment ovate, wider than long; lobes acute, spine-like; fourth legs reaching its tip *suhmi* (Brady, 1883).
9. Genital segment elliptical, longer than wide; lobes broad, rounded; fourth legs reaching its center *nordmannii* (M-Edwards, 1840), p. 623.
9. Genital segment subquadrate, wider than long; lobes broad, rounded; fourth legs reaching abdomen tip *erecsoni* (Thomson, 1890).
10. Males, both fifth and sixth legs showing plainly 11.
10. Females, only the fifth legs showing dorsally 12.
10. Females, no appendages visible dorsally 13.
11. Genital segment elliptical; fourth legs reaching abdomen tip; branches of furca bifid *hippoglossi* (Kröyer, 1837), p. 625.
11. Genital segment ovate; fourth legs not reaching its tip; furca branches flattened, foliaceous *edwardsi*, new species, p. 627.
11. Genital segment elliptical; fourth legs medium; furca branches acuminate, close together *dissimulatus*, new species, p. 631.
11. Genital segment quadrate; fourth legs medium; furca branches blunt, flanged, widely separated *purpurentis*, new species, p. 635.
12. Genital segment orbicular; abdomen minute, spindle-shaped, much widened at center *rotundiventris* (B-Smith, 1898, b).
12. Genital segment broad flask-shaped; fifth legs longer than abdomen. *cosyphi* (Kröyer, 1863), p. 644.
12. Genital segment orbicular, wider than long; abdomen nearly covered by it posteriorly *dissimulatus*, new species, p. 631.
13. Genital segment elliptical, longer than wide; lobes short, narrow; furca branches bifid, truncate *hippoglossi* (Kröyer, 1837), p. 625.
13. Genital segment orbicular, wider than long; no lobes; fourth legs two-jointed with three spines *brachyurus* (Heller, 1865).

13. Genital segment subquadrate, as wide as long; no lobes; fourth leg spines all serrate.....*edwardsi*, new species, p. 627.
13. Genital segment obovate, longer than wide; lobes very wide and blunt; no serrate spines.....*parviventris*, new species, p. 635.
13. Genital segment obovate, longer than wide; no lobes; furca branches bifid, branchlets acute.....*bifurcatus*, new species, p. 637.
14. Abdomen four-jointed, as long as genital segment; the latter trapezoidal.
pacificus (Gissler, 1883), p. 642.
14. Abdomen two-jointed, as long as genital segment; latter elliptical; males.
pollachii (B-Smith, 1896).
14. Abdomen two-jointed, shorter than genital segment.....15.
14. Abdomen one-jointed, as long as genital segment; latter ovate; lobes short, pointed.....*molre* (M-Edwards, 1836-49).
15. Males, both fifth and sixth legs visible; genital segment narrow-ovate; abdomen joints unequal.....*nordmanni* (M-Edwards, 1840), p. 623.
15. Females, genital segment without any visible appendages.....16.
16. Genital segment obcordate; abdomen twice as long as wide; joints equal; free segment as long as wide; fourth legs four-jointed, five spines.
crabro (Kröyer, 1863).
16. Genital segment obcordate; abdomen twice as long as wide; joints equal; free segment three times as wide as long; fourth legs three-jointed, four spines.....*intercurvens* (Kröyer, 1863).
16. Genital segment quadrate; abdomen as wide as long; joints equal; fourth legs four-jointed, five spines.....*pectoralis* (Müller, 1776).
16. Genital segment obcordate; basal abdomen joint four times terminal; fourth legs three-jointed, five spines.....*grolmanni* (Kröyer, 1863).
17. Abdomen two-jointed, longer than rest of body; genital segment triangular, twice the carapace.....*pharaonis* (Nordmann, 1832).
17. Abdomen two-jointed, longer than genital segment; females.....18.
17. Abdomen two-jointed, shorter than genital segment.....19.
17. Abdomen one-jointed, three times the genital segment; latter subquadrate, spiny; lobes short.....*flores* (van Beneden, 1892).
17. Abdomen one-jointed, a little longer than genital segment.....22.
17. Abdomen one-jointed, shorter than genital segment.....23.
18. Genital segment oblong, half the carapace; basal abdomen joint four times terminal.....*longipalpus* (B-Smith, 1898, b).
18. Genital segment oblong, as large as carapace; basal abdomen joint twice terminal.....*innominatus* new species, p. 656.
19. Females, abdomen distinctly more than half as long as the genital segment; fifth legs concealed dorsally.....20.
19. Females, abdomen clearly less than half as long as the genital segment; fifth legs concealed in dorsal view.....21.
20. Genital segment ovate; no lobes; fourth legs nearly reaching its tip.
sturionis (Kröyer, 1837).
20. Genital segment elliptical, lobes large; fourth legs not reaching its center.
thompsoni (Baird, 1850), p. 619.
20. Genital segment elliptical; lobes broad, but short; abdomen half its width.
salmonis (Kröyer, 1838), p. 640.
21. Genital segment quadrate, as wide as long; joints of the abdomen nearly equal.
pectoralis (Müller, 1776).
21. Genital segment elongate, twice as long as wide; basal abdomen joint three times terminal.....*bagri* (Dana, 1852).
21. Genital segment flask-shaped, a fifth longer than wide; basal abdomen joint the longer.....*quadratus* (Kröyer, 1863).

21. Genital segment oblong, twice as long as wide; basal abdomen joint the wider, but shorter.....*monacanthus* (Heller, 1865).
22. Females, genital segment quadrate, nearly as long as carapace; no lobes.
pollachii (B-Smith, 1896).
22. Females, genital segment bell-shaped, half the carapace; lobes long and broad.....*exculpatus* (Fischer, 1860).
23. Females, genital segment elliptical, lobes short and broad; fifth legs concealed dorsally.....*salmonis* (Kröyer, 1838), p. 640.
23. Males, genital segment spindle-shaped; lobes narrow and two-thirds as long as abdomen.....*flores* (van Beneden, 1892).
23. Males, genital segment broad acorn-shaped; no lobes; both fifth and sixth legs visible.....*intercurrens* (Kröyer, 1863).

LEPEOPHTHEIRUS LONGIPES, new species.

Plate XVIII, figs. 206-211, 222.

Female.—Carapace elliptical, one-seventh longer than wide. Frontal plates well rounded and deeply incised at the center. Posterior sinuses of medium width, with the sides nearly parallel; median lobe rather more than half the entire width and projecting well back of the lateral lobes. Free thorax segment four-fifths as wide as the genital segment, four times as wide as long.

Genital segment oblong, somewhat less than half the width of the carapace, a little wider posteriorly where it is produced into a narrow conical lobe on either side.

Abdomen narrow, oblong, two-jointed, the basal joint somewhat the larger. Anal laminae long, narrow, and curved inward so much at the tips that the two overlap. Egg strings about the same diameter as the abdomen and three-fourths as long as the body.

Anterior antennae two-thirds the length of the frontal plates, well-armed with setae; posterior antennae slender, the terminal claw much longer than the basal joint and curved nearly a third of its length. Both pairs of maxillae very slender, the first pair not much curved, the second pair divided about to the center with the branches close together, parallel, and both curved slightly away from the rostrum. Furca narrow and abruptly constricted at the base; the branches very thick and stout, divergent, and much longer than the base.

Second maxillipeds stout, the claw three-quarters the length of the swollen basal joint with an accessory spine longer and stouter than ordinary. The plumose setae on the first swimming legs are short and weak; the two outer terminal claws are pectinate, while the inner one is smooth. On the second legs the spine at the tip of the basal joint of the exopod is very large, nearly as long as the joint itself, and the spines on the other two joints are also large. There is a curved claw at the tip of the second joint of the endopod of these legs which is totally unlike anything observed in other species. The fourth legs are very large, relatively much longer than in any other species. The

basal joints are thick and swollen, and they reach nearly to the center of the genital segment, while the three terminal joints, much narrower, extend well beyond the tips of the anal papillæ. There are the usual five spines on these legs, arranged in the customary manner. There are several species (*erecsoni*, *hippoglossi*, *nordmanni*, etc.) in which the fourth legs of the male reach beyond the tips of the anal papillæ, but this is the first instance where the same is true of the female. Furthermore, these legs in the present species are far larger than those of any known male, the basal joint on each leg being actually larger than the entire free segment to which it is attached.

This, therefore, may be taken as the distinguishing characteristic of the species.

Total length 8.5 mm. Length of carapace 4.25 mm.; width of the same 3.6 mm.; length of genital segment 2.1 mm.; length of abdomen 1.25 mm.; length of egg strings 7 mm.; length of the fourth legs 4.2 mm., including the spines.

The color in preserved specimens is a dark yellowish gray, without any pigment visible.

(*longipes*, *longus*, long, and *pes*, foot.)

This species is very clearly differentiated from all others by the size of the fourth legs, by the shape of the furca, and by the curved claw on the endopod of the second legs.

The National Museum collection unfortunately includes only a single unnumbered lot of two females, and there are no data as to the locality or the host from which they were obtained.

LEPEOPHTHEIRUS THOMPSONI Baird.

Plate XVIII, figs. 212-219.

Lepeophtheirus thompsoni BAIRD, 1850, p. 278, pl. XXXIII, fig. 2.—WHITE, 1850, p. 121.—BASSETT-SMITH, 1899, p. 455.—T. SCOTT, 1900, p. 152, pl. v, figs. 43-45.

Caligus gracilis P. J. VAN BENEDEN, 1851, p. 90, pl. II, figs. 1-7; 1861, p. 147.—RICHIARDI, 1880, p. 148.

Caligus branchialis STEENSTRUP and LÜTKEN, 1861, p. 362, pl. II, fig. 3.—CLAUS, 1864, p. 365, pl. XXXIII, figs. 3-7; pl. XXXIV, figs. 8 and 9.

Lepeophtheirus rhombi KRÖYER, 1863, p. 118, pl. v, fig. 5, a-i.

Lepeophtheirus gibbus KRÖYER, 1863, p. 121, pl. XVII, fig. 2, a-i.

Lepeophtheirus gracilescens KRÖYER, 1863, p. 124, pl. VI, fig. 2, a-i.

Lepeophtheirus gracilis CARUS, 1885, p. 359.—BRIAN, 1898, p. 12, pl. I, fig. 5; 1899, p. 3.

Lepeophtheirus obscurus BASSETT-SMITH, 1896, a., p. 157; 1896, b., pl. IV, fig. 2.

Lepeophtheirus branchialis BASSETT-SMITH, 1899, p. 456.

Lepeophtheirus obscurus T. SCOTT, 1900, p. 153, pl. VI, figs. 16-19.

Female.—Carapace obovate, a little wider than long, not much narrowed anteriorly. Frontal plates narrow but distinct, without any incision at the center. Posterior sinuses widely triangular and shallow, leaving a median lobe less than half the entire width and not projecting beyond the lateral lobes.

Of the grooves separating the carapace areas, the crossbar of the "H" is much farther forward than in the preceding species, four-ninths, or nearly half, the distance from the posterior margin. Moreover, it is strongly curved forward, and, together with the posterior portion of the lateral grooves, it forms a nearly perfect semicircle. The lateral grooves are not parallel with the margin of the carapace, but diverge widely from it. The eyes are smaller than in *innominatus*, but are situated in about the same relative position.

The free thoracic segment is less than half the width of the genital segment, subtriangular in shape, and narrowed into a neck anteriorly where it joins the carapace. This is in marked contrast with *innominatus*, the anterior margin of whose free segment is its widest part.

The genital segment has an elongate flask shape, narrowed into a neck anteriorly, and then widening to about two-thirds the width of the carapace. It is one-fourth longer than wide, with a deeply emarginate posterior border and well-rounded lobes at the angles. The abdomen is two-fifths the width of the genital segment and two and a half times as long as it is wide.

It is two-jointed, the basal joint nearly three times as long as the terminal. The abdomen is somewhat swollen at the joint, and then tapers rapidly toward the tip. The anal laminae are small and widely separated, with the tips curved in toward each other. The setae are also very small and slender.

The egg strings are only half the diameter of the abdomen and about as long as the entire body. The eggs are thick, and number 125 or 130 in each string.

The first antennae are relatively smaller than in *innominatus*, but are as well provided with setae and spines; the second pair are small, with a short terminal hook.

Both pairs of maxillae are slender, the second pair divided nearly to their base with narrow, slender, divergent branches.

The furca is relatively large, fully twice the size of that in *innominatus*; it is strongly narrowed at the base and then widens into a broad U-shape, with dilated branches.

The second maxillipeds are large but not to be compared with those in *innominatus* for size; the terminal claw is nearly as long as the basal joint, but rather slender and strongly curved.

The first swimming legs have a stout spine on the posterior margin of the basal joint and another at the anterior distal end of the second joint, with the usual setae and terminal spines on the last joint. The fourth legs are short and small, four-jointed with five spines; but one of the spines is at the outer distal corner of the basal joint and there is none on the second joint. These legs are about one-third the length of the genital segment. The fifth legs are invisible in a dorsal view.

Total length 8.4 mm.; length of carapace 3.2 mm.; width of same 3.4 mm.; length of genital segment 2.8 mm.; length of abdomen 2.1 mm.; length of egg strings 8.5 mm.; 125 or 130 eggs in each.

General color a light yellow, the hard parts turning much darker on preservation.

(*thompsoni*, to William Thompson, who did much valuable work on the Irish fauna.)

Male.—Carapace elliptical, one-sixth longer than wide, with evenly rounded sides. It is twice as long and nearly three times as wide as the rest of the body. The posterior sinuses are shallow and considerably narrower than in the female, but the grooves and general proportion of the parts are the same.

The free segment is more than half the width of the genital segment and is swollen at the center through the bases of the fourth legs, so that it becomes spindle-shaped.

The genital segment is orbicular, of about the same length and width, one-third the length of the carapace. It carries two pairs of setiferous papillæ, one on the lateral margins near the posterior corners and the other pair at the corners.

The posterior margin between the latter papillæ is slightly concave. The abdomen is half the length of the genital segment, a little longer than it is wide, and strongly narrowed at the base. The anal laminae are minute and carry small setæ. In the appendages there is the usual increase in the size of the second antennæ and second maxillipeds; otherwise the appendages are like those in the female.

Total length, 4 mm. Length of carapace, 2.8 mm.; width of the same, 2.4 mm.; length of genital segment, 0.7 mm.; length of abdomen, 0.4 mm.

The specimens of this species in the possession of the National Museum were obtained from Rev. A. M. Norman. The lot is numbered 8032 and consists of females only, taken from the turbot, *Rhombus maximus*, at Cornwall, England.

In all probability this is the species referred to by S. I. Smith (1874, p. 281) as found on the sting-ray (*Dasyatis centrura*) in Vineyard Sound; but those specimens were not preserved, and none have since been obtained from the same fish.

But during the past season the author received from Mr. V. N. Edwards a single female of this species taken from a goosfish at Woods Hole.

There has been the utmost confusion in the description of the species of *Lepeophtheirus* infesting the common turbot and brill of European waters. There are no less than seven species of this one genus, all claiming to be valid and all infesting the same fish. These seven species are as follows, given in the order of their discovery: *Lepeophtheirus thompsoni* Baird, 1850; *gracilis* van Beneden, 1851; *branch-*

ialis Steenstrup and Lütken, 1861; *rhombi*, *gibbus*, *gracilescens* Kröyer, 1863; *obscurus* Bassett-Smith, 1896.

The figures given by the various authors all show the same general proportions, body regions, and appendages, especially the small fourth legs. It is obviously impossible that there should be so many species of the same genus on one fish and corresponding so closely. And when we come to examine the figures and descriptions carefully we are at a loss to discover anything of specific value. The differences are all trivial and of no greater value than those recorded under the single species *Caligus rapax*.

Bassett-Smith in his description of the species which he calls *obscurus* makes his specimens, which were all females, the same species as Baird's male, which the latter described in 1850.

This decision is based upon the bifurcation of the branches of the furca. If that were correct it would come the nearest to a specific difference of anything connected with the entire seven species. But Bassett-Smith in his first paper (1896) calls this species (*obscurus*) a *Lepeophtheirus*; in another paper published the same year he labels the figure he presents *Caligus*, and puts a pair of lunules in the frontal plates; again in 1899 he goes back and calls it *Lepeophtheirus*.

In the face of such vacillation too much stress can not be placed upon the bifurcation of the branches of the furca, especially as this one detail is all he has ever presented in the way of a description.

Baird himself suggested in his original description that the male he described as *obscurus* might very well be the male of the species *hippoglossi*, only the female of which was then known.

If his figure be compared with that given by other authors of a male *hippoglossi*, the resemblance will be found very close.

Furthermore Bassett-Smith places a question mark in every instance after the name of his species. Until he can give us more convincing proof, therefore, and a better description of his species we are not warranted in accepting its validity.

With reference to Beneden's species it is enough to say that not very much credit can be given to an author who represents the fourth legs as attached to the basal apron of the third legs, while the true rami of the third legs are attached to the lateral lobes of the carapace(!).

A careful reading of Kröyer's diagnosis of the three species *rhombi*, *gibbus*, and *gracilescens*, together with a comparison of the figures he presents, will quickly convince one that the three are identical. All the details which he gives of the appendages show absolutely no differences, except trifling ones of size. The second antennæ, second maxillæ, furca, second maxillipeds, and third and fourth swimming legs are identical. The proportions of the different regions are also very nearly identical, only such slight differences as occur in any species. His specific distinctions, so far as one can judge, rest solely upon the

size and shape of the carapace and of the genital segment, and he was working entirely with preserved material.

The carapace is the one part of all others to be modified in a preserving fluid, while a candid examination of the genital segment of any common species will show that it is capable of much variation, even in living specimens. We are compelled to the conclusion, therefore, that we have here only a single species subject to local variations, and that the various forms given as distinct species are nothing more than varieties. And of them all Krøyer's *gracilescens* is the most worthy of separation as a well marked variety.

With reference to Steenstrup and Lütken's species *branchialis* the figure which they give entire shows a genital segment quite different in shape from that which has been taken as typical of *thompsoni*. But the detail of the appendages, of which they present most admirable figures, corresponds exactly with *thompsoni*. And they add a partial figure showing the free and genital segments and the abdomen, which they declare illustrates a common variation, and which corresponds very closely with that here given. Furthermore, they, as well as Claus, give *Caligus gracilis* van Beneden as a synonym under *Caligus branchialis*. The priority of *branchialis* presumably rests upon the fact that it is a manuscript name given by Malm, to whom they ascribe the species. But as Malm's manuscript was never published, and hence Beneden's name, *gracilis*, antedates it by ten years, *branchialis* would have to be regarded as a synonym of *gracilis* rather than vice versa.

The important fact for us is that the two species are identical, and that the one (*branchialis*) for which we have reliable details seems to be identical also with *thompsoni*.

Finally the seven species here discussed agree remarkably in size, the range being from 7 mm. in *gracilescens* to 8.4 mm. in *thompsoni*, or less than a millimeter and a half, which is no more than would be expected in so large a species.

LEPEOPHTHEIRUS NORDMANNII Milne-Edwards.

Plate XIX.

Caligus nordmannii MILNE-EDWARDS, 1836-1849, pl. LXXVII, fig. 1; 1840, p. 455.

Lepeophtheirus nordmannii BAIRD, 1850, p. 275, pl. XXXIII, fig. 1.—HELLER, 1865, p. 180, pl. XVI, figs. 1 and 2.—RATHBUN, 1884, p. 487.—THOMPSON, 1895, p. 118, pl. XXVII, fig. 5, a.—T. SCOTT, 1900, p. 151, pl. v, figs. 32-37.

Female.—Carapace orbicular, as wide as long, and very squarely truncated posteriorly, or even slightly emarginate. Frontal plates small and narrow and not very well defined; posterior sinuses broad, deep, and well rounded. Median lobe about one-half wider than the lateral lobes, squarely cut or emarginate posteriorly, with sharp corners terminating in short spines.

Grooves separating the carapace areas considerably different from those in other species. The two longitudinal grooves forming the sides of the "H" are strongly inclined toward each other anteriorly, and there are two crossbars instead of one, dividing the length of the carapace into quite even thirds. Eyes very small and situated just in front of the anterior crossbar. Free thorax segment subtriangular in shape and a little more than half the width of the genital segment.

Genital segment obovate, not quite half as wide as the carapace, with broad and well-rounded posterior lobes. Abdomen spindle shaped, half the length of the genital segment, with a strongly emarginate posterior margin. Anal laminae large and curved in well toward each other.

The characteristic of the appendages is great length, combined with a reduction in width, making them appear very slender. The first antennae are somewhat of an exception to this rule; they are slender, but are also very short and hardly show at all on the anterior margin. But in the second pair the terminal hook is nearly twice the length of the basal joint and is bent into an almost perfect sickle shape.

Both pairs of maxillae are much elongated and narrowed, the branches of the second pair diverging considerably. The terminal claw of the second maxillipeds is longer than the basal joint and strongly curved, but its accessory spine is small and weak.

The furca is much elongated, with widely divergent and slender branches, which are somewhat enlarged at the very tips, but these tips are not acuminate in American specimens, as was noted by Baird in European specimens; they are rather blunt.

The first three pairs of thoracic legs are normal; the fourth pair have a spine at the outer distal angle of every joint and three terminal ones. The two largest of these latter are very distinctly toothed. The fifth pair of legs, which are ordinarily rudimentary papillae, are in this species quite broadly foliaceous, but they do not protrude far from the ventral surface.

Total length, 10 to 12 mm. Length of carapace, 5.5 mm.; width of the same, 5.4 mm.; length of genital segment, 2.85 mm.; length of abdomen, 1.5 mm.; length of egg strings, 7 mm.

Color a dark yellow-white, without pigment spots of any kind.

Male.—Carapace a little longer than the rest of the animal and itself longer than wide, narrowed anteriorly and quite strongly convex. Frontal plates rather more distinct than in the female; frontal margin slightly rounded with a broad notch at the center. Free segment much longer and narrower than in the female, about one-fourth the length and one-fourth the width of the carapace; considerably widened at the center through the bases of the fourth legs. Genital segment acorn-shaped, longer than wide, much narrowed anteriorly and deeply emarginate posteriorly; furnished with two acute lobes on either side at the

posterior corner. Abdomen only one-third the length of the genital segment, but two-jointed, the joints unequal, the basal one wider and the terminal one longer. Anal laminae small, nearly linear, furnished with short setae.

Of the appendages the second antennae are branched as usual in males. The first maxillae are very long and sickle-shaped. The second maxillipeds have a stout spine or tooth on the inner margin of the basal joint. The other appendages are the same as in the female.

Total length, 5 mm. Length of carapace, 2.75 mm.; width of same, 2.5 mm.; length of genital segment, 1.65 mm.; length of abdomen, 0.75 mm.

(*nordmanni*, to Dr. Alexander v. Nordmann.)

This species was first described by Milne-Edwards in 1840, under the genus *Caligus*. This error was corrected by Baird in 1850, and the species was placed under the genus *Lepeophtheirus*, which had been founded by Nordmann himself in 1832.

It is apparently confined to the sunfish of our own coast and in European waters, as all the recorded specimens have been obtained from that fish. And it is not very abundant, only a few specimens being obtained from among the many parasites which infest one of these fishes. The National Museum collection includes three lots, 6018, 12667, 12668, the first and last from the vicinity of Woods Hole, the other from Casco Bay.

LEPEOPHTHEIRUS HIPPOGLOSSI Kröyer.

Plate XX, fig. 6 in the text.

Caligus hippoglossi KRÖYER, 1837, p. 625, pl. VI, fig. 3 A. and B.—MILNE-EDWARDS, 1840, p. 456.—RATHKE, 1843, p. 102.—STEENSTRUP and LÜTKEN, 1861, p. 355.

Lepeophtheirus hippoglossi BAIRD, 1850, p. 276, pl. XXXII, fig. 12.—KRÖYER, 1863, p. 131, pl. VI, fig. 5, a-d.—T. SCOTT, 1900, p. 151, pl. V, figs. 38-42; pl. VI, figs. 1-2.

Female.—Carapace elliptical, widest at the center, one-fourth longer than wide. Frontal plates very distinct, but rather narrow. Posterior sinuses shallow and widely separated, leaving the median lobe fully half the entire width of the carapace. This lobe has a very flat posterior curve and usually overlaps the free segment. The lateral lobes are short and curved inward strongly at their tips.

Free segment one-eighth the length of the carapace and four-fifths as wide as the genital segment, the portion to which the fourth legs is attached projecting strongly on either side.

Genital segment three-fifths the length of the carapace, narrow, elliptical in outline, the length to the width in the proportion of 5 to 4; posterior lobes narrow and pointed.

Abdomen very small, about one-tenth the entire length, rather conical in shape, and terminating in a pair of small anal laminæ armed with short plumose setæ.

Terminal joints of the first antennæ long and slender, club-shaped, with only a few small setæ. Second antennæ with a stout basal joint and a long and strongly curved terminal claw. Maxillæ relatively very large, the first pair close to the tips of the second antennæ, the second pair in the usual place beside the proboscis. Each of this second pair is fully as large as the entire proboscis, projects far beyond the tip of the latter, and is bipartite for its terminal half. Each branch is the shape of a sharp cone with a wide flange or wing on either side at the center.

The proboscis is short and wide and bluntly rounded at the tip, mouth opening terminal. The mandibles are long and slender, the last joint short, quite strongly curved and toothed along its inner margin. First maxillipeds normal; second pair slender, the terminal claw but little more than half the length of the basal joint; the accessory spine so small as to be easily overlooked. Furca long, narrow at the base but flaring rapidly toward the tip, the prongs strongly flattened, laminate, and each divided nearly to its base by a narrow sinus, leaving the secondary branches with squarely truncate ends and parallel sides. The central sinus is a broad U-shape, with a square base and slightly converging sides.

The first swimming legs are stout, the basal joint with a short spine on its posterior margin, the second joint unarmed, the terminal joint as in other species. Third legs with large and powerful basal apron, but with very small and weak rami, scarcely projecting from the fringe along the border of the apron. Fourth legs large and stout, with four joints and four spines, the longest terminal one toothed on its outer margin. Fifth legs situated close to the openings of the oviducts and so rudimentary as to be scarcely visible.

Total length 12 mm. Length of carapace 7 mm.; width of same 6 mm.; length of genital segment 4 mm.; length of abdomen 1.2 mm.; length of egg strings 15 mm.

Color a light yellow, beautifully marked with spots of pink or red distributed all over the body and the basal joints of the fourth legs in an irregular pattern.

Male.—Carapace orbicular, as wide as long, the posterior sinuses broader than in the female, the median lobe relatively narrower and well rounded posteriorly, the lateral lobes not curved inward at their tips. Free thoracic segment wider than the genital segment and about half as long.

Genital segment small, of about the same length and width, and carrying two pairs of large papillæ. One pair projects backward from the lateral margin about one-third the distance from its posterior

end; the other pair are situated at the posterior corners. The papillæ are all about equal in size and each is furnished with three small setæ.

The abdomen is rather more quadrilateral than in the female, the anal laminae are larger, and their setæ are much longer.

The chief difference in the appendages is found in the usual enlarging of the second antennæ and second maxillipeds. The fourth legs are also relatively larger and project beyond the tips of the setæ on the anal papillæ, but their structure is the same as that in the female.

Total length 7.2 mm. Length of carapace 4.85 mm.; width of same 4.75 mm.; length of genital segment 1.35 mm.; length of abdomen 0.7 mm.

Color as in the female.

(*hippoglossi*, generic name of its host.)

Like the preceding species, this one was first described by Krøyer and Milne-Edwards under the genus *Caligus*, and was first recognized as a true *Lepeophtheirus* by Baird in 1850.

Like *nordmannii* also it seems to be practically confined to a single species of fish, the halibut, the few specimens obtained from other fish having probably been rubbed off a halibut caught in the same boat, as suggested by various authors.

The National Museum collection includes lots numbered 8031, 12038, 12631, 12634, and 30044, all from halibut caught off Greenland, Iceland, and Cape Ann. 8031 are type specimens from Shetland.

LEPEOPHTHEIRUS EDWARDSI, new species.

Plate XXI; Plate XXII, fig. 258; figs. 1, 4a, 4b, 11, 31, 34, 39 in the text.

Female.—Carapace ovate, widest posteriorly, longer than wide. Frontal plates distinct, strongly curved, not quite half the width of the carapace. Posterior sinuses shallow, wide, and well rounded. Median lobe three-eighths the entire width, squarely truncated posteriorly, and projecting well back of the lateral lobes. The latter are short, blunt, and straight (fig. 244).

Free thoracic segment of medium length and about half as wide as the genital segment, contracted anteriorly where it joins the carapace. Genital segment slightly obovate with gracefully rounded sides and angles, contracted to a very short neck before joining the abdomen. The latter is one-fifth as long as the genital segment, wider than long, and tapering posteriorly. It is made up of a single joint which is cut for one-third of its length at the anus. Anal papillæ small, wider than long, with short and stout setæ. Egg tubes nearly as long as the entire body and as wide as the abdomen, each containing 75 to 80 eggs.

Anterior antennæ of medium size, and well armed with spines and setæ; posterior pair rather slender and strongly curved.

All the other appendages are either lamellate or furnished with lamellæ somewhere in their structure.

The two pairs of maxillæ have wide wings along either side of the the central spines; in the second maxillæ, although the spines are well separated and divergent, these wings nearly touch each other at the center. The first maxilliped has a spatulate lamella instead of a spine inserted in the inner margin of the terminal joint near its center.

The second maxillipeds are large and stout, with a swollen basal joint furnished on the posterior ventral margin, where it joins the body, with a stout tongue-like lamella which projects downward at a right angle to the ventral surface. The terminal claw is three-quarters as long as the basal joint, rather slender, and furnished with a very long and hair-like accessory spine on its inner margin. Furca large, the base longer and narrower than the branches, and both base and branches strongly flattened into fan-like lamellæ. The branches are nearly twice as wide as long, with radiating ridges and lines extending outward from the thickened center. The median sinus is triangular, the branches being so widened toward the tip as to nearly meet.

The first swimming legs have a small spine on the end of the basal joint pointing outward, and a much stouter, blunt spine on the posterior border of the same joint pointing backward.

The three claws on the terminal joint are about equal, with serrated lamellæ along their posterior margins. The second legs have a wide, rounded flange or wing along the outer margin of the exopod. The fourth legs are stout and four-jointed; the basal joint is swollen and carries a slender, flexible hair on its outer margin near the distal end.

The short curved claw at the tip of the second joint, and the longer ones on the third and fourth joints, are flanged on one or both sides with serrate laminae.

The fifth legs are distinct and of medium size, plainly visible ventrally, but not dorsally.

Total length, 7.5 mm.; length of carapace, 4 mm.; width of same, 3.75 mm.; length of genital segment, 2.25 mm.; length of abdomen, 0.6 mm.; length of egg strings, 5.5 mm.

Color a delicate pinkish yellow, with small pigment spots of a purplish or reddish brown distributed evenly over the entire dorsal surface, so that the color is uniform throughout.

Under strong magnification each spot is seen to be very irregular, and to consist of a dark-blue center bordered with purple, in both of which the pigment is in small granules of uneven size, those in the purple being the larger. From this granular center narrow convoluted processes extend outward in every direction. In these the pigment is dark orange in color and is not granular, but like a water-color wash. The combination is very striking, and affords the most noteworthy instance of pigmentation thus far found among these parasites.

Male.—Carapace as in the female, except that it is relatively much larger, five-eighths of the entire length (fig. 245).

Free thoracic segment considerably shortened by the overlapping of the median lobe of the carapace. Unlike the condition in most males this segment is not proportionally wider than in the female. The genital segment and the abdomen together form an almost perfect oval, the widest end being anterior, while it narrows rapidly posteriorly.

The genital segment is one-third the length of the carapace, considerably wider than long, and squarely truncated posteriorly. It is furnished with two pairs of large papillæ—one on the lateral margins, one-third the distance from the posterior end, the other pair at the posterior corners. In both pairs the papillæ are sharply conical and furnished with quite large plumose setæ. The testes are very large, elongate-elliptical in shape, and they fill nearly the entire segment. The semen ducts open on the posterior ventral surface, on either side of the abdomen. The abdomen and the anal papillæ are similar to those of the female. There is the usual difference in the appendages, but, while the second antennæ are increased in size, they are not branched as much as in most species.

Instead, at their bases are two large corrugated ridges of chitin, inclined diagonally outward from the mid line, which serve to prevent slipping.

Total length 3.6 mm. Length of carapace 2.2 mm.; width of same 2.2 mm.; length of genital segment, 0.8 mm.; length of abdomen 0.3 mm.

Color as in the female.

(*edwardsi*, to Vinal N. Edwards, of the United States Fish Commission at Woods Hole, who discovered the species and collected nearly all the specimens.)

Nauplius.—Body obovate or slightly spindle-shaped in outline, and almost exactly twice as long as wide. The posterior end is quite squarely truncated, while the anterior end is well rounded (figs. 39 and 257).

There are the usual three pairs of appendages, which do not differ in form from those of other nauplii, except perhaps that they are a little stouter. But the balancers on either side of the anus are considerably shorter and wider than in most nauplii examined. They are also considerably swollen at the outer ends and somewhat curved.

The pigment is a distinctive bright purple, foreshadowing that of the adult, but it is distributed very sparingly in irregular patches, which vary much in position, size, and shape. Sometimes there are three pairs of patches along the sides of the posterior part of the body, a central patch between the anterior pairs, and an anal patch, each resembling a piece of tattered cobweb. But more often there is no regularity whatever in the arrangement, the only constant factor

being that the pigment is confined to the posterior two-thirds of the body, with traces also in the antennules. The eye and brain are distinctly bilobed, each half semilunar in shape, the two convex sides facing each other and fused at their centers, giving the whole very much the shape of a rough H.

Total length 0.5 mm.; width 0.26 mm.

After the first moult the larva becomes decidedly ovate, the pigment increases considerably in area, the eye moves back from the anterior edge of the carapace, and through the skin at the posterior end of the body can be seen the segmentation and the rudimentary legs of the metanauplius stage.

Chalimus.—Carapace elongate and spindle-shaped; frontal plates distinct and projecting strongly, giving the anterior portion of the body a triangular outline; the frontal filament at the apex of this triangle large and strong. The anterior portion of the carapace is considerably narrowed. The posterior sinuses are also narrow and not very deep. The median lobe is seven-tenths of the entire width and projects for three-quarters of its length behind the small lateral lobes. The transverse groove of the carapace is only a short distance in front of the posterior sinuses, leaving the cephalic area much larger than the thoracic, in spite of the great development of the median lobe. Eyes showing yet as two distinct half moons fused on their convex sides, and situated at some distance from the anterior border. Free segment as wide as the segments posterior to it and quite long; genital segment and abdomen fused into an elongate ovoid, showing by a slight constriction near the center where the two are to separate; anal papillæ large and well provided with stout setæ (fig. 258).

Color a pinkish yellow with pigment spots of the same purple as in the nauplius and adult, rather sparingly and irregularly scattered over the posterior two-thirds of the carapace; almost none anywhere else on the body.

Total length 2.55 mm.; length of carapace 1.52 mm.; width of same 1 mm.; length of remainder of body 1 mm.

This is undoubtedly the species mentioned by Smith (1874, p. 281) as found upon the flounder, *Chænopssetta ocellaris*, and which he designates as "a species with a very short tail, and approaching Heller's genus *Anuretes*." It is fairly common on the four-spotted flounder (*Paralichthys oblongus*), but is not often found upon the summer flounder. It affords a notable example of color protection, for the pigment spots with which it is covered give it so nearly the hue of the dorsal surface of its host that it can be distinguished only when in motion.

It is always found upon the external surface, and so far as observed always on the dorsal side of the body. It shows no decided preference

for any particular locality, but may be found anywhere from the outside of the operculum to the tip of the tail.

When disturbed the males scuttle about over the surface in a lively manner, but the females ordinarily remain quiet. In the aquarium both sexes swim about freely, but the male is the more lively and usually lives longer. They can be kept more successfully than many other species, and do not bother by crawling up out of the water. Females with eggs which are nearly ripe retain the egg strings even under rough treatment, and the nauplii may be reared successfully. The egg cases are separated rather more than usual at their origin in the genital segment. At first they approach each other rapidly until about their own diameter apart, and then extend backward parallel with each other. They are light colored even when well developed, so that it is difficult to judge of their maturity by their color. This is due to the paucity of pigment in the larvæ.

The National Museum collection includes the following lots of this parasite, from the summer flounder (*Paralichthys dentatus*) 6065, 6081; W. 61; W. 62; W. 65; W. 73, all from Woods Hole and vicinity.

From the four-spotted flounder (*Paralichthys oblongus*) 1285 (two lots with the same number), 1308, 6040, W. 63; W. 64; W. 67; W. 68, all also from the vicinity of Woods Hole.

From an unknown host 4403 from Great Egg Harbor, New Jersey, and W. 66 from an unknown locality.

From the horse crevalle (*Caranx hippos*) a single specimen taken at Woods Hole, W. 69.

From the garfish (*Tylosurus marinus*) a single male taken at Woods Hole, W. 70, and from the summer skate (*Raja erinacea*) a single female at the same locality, W. 71.

LEPEOPHTHEIRUS DISSIMULATUS, new species.

Plate XXII.

Female.—Carapace orbicular, the width and length almost exactly equal; frontal plates large and well defined. Posterior sinuses shallow and broadly triangular; median lobe fully half the entire width of the carapace, projecting but slightly beyond the lateral lobes and squarely truncated posteriorly, sometimes slightly emarginate. Transverse groove in the center of the carapace, its halves nearly straight lines and inclined toward each other like the sides of a roof. Eyes small and placed well forward. Free thoracic segment short and a little more than one-third as wide as the genital segment, with the base of the fourth legs projecting strongly.

Genital segment a sphere, flattened antero-posteriorly, its diameter a little more than half that of the carapace, its dorsal surface overhanging the ventral posteriorly. From the rounded posterior margin

of this dorsal surface, opposite each egg tube, projects a short, conical papilla, without setae or spines.

From the ventral surface on either side of the abdomen and at a little distance from it, a second pair of papillae project backwards. These are much larger than the first pair, and each of them carries three good-sized plumose setae. These latter are not arranged in a trio at the tip as usual in this genus, but stand in a row along the outer margin of the papilla, one close to the tip, another near the center, and the third between these two. In the Bermuda specimens there is also a third pair of papillae, each of which is situated just outside and superior to the base of the large ventral papilla on its side. This third pair is the smallest of the three, and each of its papillae is tipped with a single long and slender seta. The large ventral pair evidently represent the fifth legs; the other pairs are simply processes without special significance. Abdomen small, less than one-third the length of the genital segment, and attached to the ventral surface of the latter in front of its posterior border, so as to be almost wholly concealed in a dorsal view. It is swollen a little near the base, and then at the base where it joins the genital segment it is abruptly contracted into a short neck of about one-third its full diameter. It is made up of a single segment, three-fifths as wide as long, and terminates in laminae, which are three-quarters of its own length. These laminae are half as wide as long, and are armed with four slender plumose setae considerably longer than both abdomen and laminae. The egg strings are wide and a little more than half as long as the whole body. Eggs very large, their antero-posterior diameter being often fully half their lateral diameter, and hence only 15 to 25 eggs in each string.

Since the abdomen is thus upon the ventral surface, while the openings of the egg tubes are in the center of the posterior surface dorsal to the abdomen, it follows that the egg strings, when extruded, cover the dorsal surface of the abdomen, and practically complete the concealment partially accomplished by the overhanging of the dorsal surface of the genital segment. This position of the egg strings, dorsal to the abdomen, is very unusual in the genus, the two being exactly reversed in relation in all other known species.

In the appendages the basal joint of the first antennae is robust and heavily armed with spines along its anterior and inner border. The terminal segment is slender, longer than the basal, and armed with numerous spines toward the distal end, and a single one at the center of the posterior border.

Second antennae of medium size, with the terminal hook strongly curved. Both pairs of maxillae consist of single curved spines, the first pair strongly curved, the second pair nearly straight. Terminal claw of the second maxillipeds less than half the length of the basal joint, the latter being fairly stout.

Furca small with parallel branches separated by a V-shaped sinus reaching beyond the center. The shape varies slightly in the specimens from the two localities as indicated in the figures. First swimming legs short and stout, the basal joint with a stout spine on its posterior border, the two inner terminal claws pectinate.

Exopods of the second and third legs armed with long and stout spines. Fourth legs of medium size, the basal joint about as long as the other three and bearing a single small spine on its outer margin near the distal end. A very long and slender spine at the distal end of the second joint, a shorter and stouter one on the third joint, the two inner terminal claws pectinate, the outer one very long and slender. Fifth legs large and well defined as already described, protruding for more than half their length beyond the posterior margin of the genital segment. They are broad at the base, but taper to a narrow tip, with the plumose setæ on the terminal half. This arrangement is totally different from that in any other species, except *parviventris*, and may be used to great advantage in determining the species.

Total length, 3.5 mm. Length of carapace, 2.3 mm.; width of same, 2.3 mm.; length of genital segment, 1 mm.; length of egg strings, 2 mm.; 15 to 30 eggs in each.

Color a uniform dark yellow without pigment spots.

(*dissimulatus*, *dissimulo*, to conceal what really exists.)

Male.—Carapace similar to that of the female. Free thoracic segment relatively much larger, fully as wide as the genital segment and nearly half as long, with the bases of the fourth legs protruding as prominently as in the female.

Genital segment elliptical in outline, about as wide as long, and squarely truncated posteriorly. The fifth legs appear as a pair of prominent papillæ projecting from the posterior lateral margin on either side, each papilla carrying three long spines.

Abdomen very short, wider than long; anal papillæ large and armed with plumose setæ even longer than those in the female.

The second antennæ are much longer than in the female and branched several times like a stag's horn; they evidently make effective clasping organs. The other appendages are as in the female, except the fourth legs, which are relatively much larger and stouter.

Total length, 2.5 mm.; length of carapace, 1.7 mm.; width of same, 1.6 mm.; length of genital segment, 0.37 mm.; length of abdomen, 0.2 mm.

The National Museum collection consisted of one lot, 1505, taken from the white-spotted serranus, *Epinephelus labriformis*, at Charles Island, one of the Galapagos group. This lot includes a male with ten females, but the latter were not very well preserved, and hence the author was much pleased to receive a second lot of four females, admirably preserved, which had been taken from a red grouper,

Epinephelus morio, at the Bermuda Islands, by Dr. Edwin Linton, in the summer of 1903. It is from these latter specimens that most of the female characters in the present description are taken. These females resemble those described by Bassett-Smith under the name *L. rotundiventris*,^a but the male is entirely different from the one which he pictures.

If he is right, therefore, in assigning the male and female which he describes to the same species, we have here a markedly different form. But, whether right or wrong, the present species shows enough important differences to leave no doubt of its validity. In this species the second maxilla is much longer than in Bassett-Smith's species and the tip is not bifid in either sex. The furca is cut for three-fifths of its length rather than for one-tenth, as in *rotundiventris*, and it is widest at the tip instead of at the base.

The detail of each pair of legs, especially the fourth, differs considerably in minor characters. The abdomen in *rotundiventris* is attached on a level with the dorsal surface, as is usual. It is widest in the center and tapers much toward the tip, where are attached the small laminae.

In the present species the abdomen is attached on a level with the ventral surface and so far forward that the overhanging dorsal surface nearly conceals it in a dorsal view. It is widest at the base, and then abruptly contracted where it joins the genital segment, and to its tip are attached a pair of laminae nearly as large as the abdomen itself. In the present species, also, the male's genital segment is radically different from that of the female, and is like that in other species. It is flattened dorso-ventrally, has an acorn-shape, and is furnished with two pairs of papillae, one on the lateral margins and one at the posterior corners. It does not project dorsally over the abdomen, but the latter is attached to it, as in other species, on a level with the dorsal surface.

The general relation of the different regions in the male would thus correspond closely with that of both sexes in Bassett-Smith's species, but the details of structure are very different.

Another thing which renders the present species interesting is the thickness and paucity of the eggs. In no other species, except *bifurcatus*, is there any approach to the condition found here. That this is no accidental occurrence, nor the result of immaturity, is shown by the fact that the egg strings of all the females are almost exactly alike. Furthermore, a careful examination of the egg cases at the point of their attachment to the genital segment shows that all the eggs have been extruded, and the cases have been pinched off and closed, as is normally done at the conclusion of egg extrusion.

^aHe has used the term "ventris" here to express a portion of the thorax; it is the genital segment which is rotund and not the abdomen.

Such a marked restriction in the number of eggs would lead us to search for some accompanying advantages in the struggle for existence. One thing which suggests itself is a superior activity. All the swimming legs in the adult are powerfully developed, particularly the basal apron of the third pair. This constitutes the chief organ of locomotion as already suggested, but whether there is a similar superiority in all the stages of development only a careful study of the nauplii and chalimus stage can determine.

But the chief interest of the species lies in its morphological relation to such forms as *Caligus* and *Lepeophtheirus* on the one side and the genus *Anuretes* on the other. In the latter genus the anal laminae are attached directly to the ventral surface of the genital segment, and usually at some little distance from the posterior margin of the latter. It would be difficult to know just how to account for the disappearance of the abdomen were it not for the present species. But the structure here seems to indicate clearly that, starting from the dorsal surface and of a normal size, the abdomen has retreated gradually, first to the ventral surface, and then away from the posterior margin, diminishing in size all the while, until it has been finally absorbed into the genital segment.

The anal laminae have not participated in the diminution, but, retaining their original proportions, when the abdomen has disappeared they still remain on either side of the anus as morphological indicators of the degeneration which has taken place.

LEPEOPHTHEIRUS PARVIVENTRIS, new species.

Plate XXIII, figs. 275-284.

Female.—Carapace obovate, one-eighth longer than wide, broadest posteriorly. Frontal plates of medium size and well defined; posterior sinuses broad, shallow, and quite widely separated, leaving the median lobe four-ninths of the entire width and rather squarely truncated posteriorly. Lateral lobes broad and well rounded. Free thoracic segment considerably less than half the width of the genital segment, and of medium length. Genital segment a little more than half the length of the carapace, as wide as long, and with nearly parallel sides and broad, well rounded posterior lobes. Abdomen quadrangular and very small, only one-third the length of the genital segment, and wider than long. Anal laminae large and curved outward, each one armed with four long plumose setae.

The two joints of the first antennae about the same length, and both plentifully supplied with setae. The second antennae short and small, the terminal hook slender and strongly curved.

The first maxillae are as large as the claw of the second antennae and as strongly curved. The second maxillae are also large, the branches slightly longer than the basal portion, and curved in toward each

other. Each branch is slender, conical, and rather blunt, without flanges or wings of any sort.

Between the bases of these maxillæ and those of the second antennæ there is on either side a pair of conical papillæ. The larger of these is in a line between the two appendages mentioned, and is furnished with a stout spine which is inclined strongly backward. The other smaller papilla, which is without a spine, joins the larger one on its outer border. These evidently represent the rudiments of the endopod of the second maxillæ. The first maxillipeds are slender, the terminal joint nearly twice the length of the basal and ending in three long setæ, the inner two of which are pectinate. The second maxillipeds are stouter, with the terminal claw nearly as long as the basal joint and acuminate; the accessory spine is long and slender. Furca short and very wide, the branches longer than the base, widely separated, and nearly parallel, with the intervening sinus but little rounded. The branches are short and blunt with a slight flange on the inner side, making them widest at the center.

The first swimming legs are short and stout, the basal joints connected across the median line by a narrow band of chitin, and each of them armed posteriorly with a short, blunt spine. The second joints are fringed with hairs posteriorly and carry a single small spine at the distal end anteriorly. The three terminal claws decrease in size posteriorly, the third one being only half as long as the first. The seta at the distal corner is very small, being no longer than the shortest claw. The second pair of legs are also stout, the basal joints being nearly circular in outline and densely fringed with hairs around their entire margin. The basal joint of the exopod is noticeably long, and the spines are slender and sharp. The rami of the third legs are large and close together, the spine at the base of the exopod being twisted until it is nearly parallel with the margin of the basal apron. The fourth legs are large and reach back considerably beyond the posterior margin of the genital segment; they are four-jointed, the basal and third joints carrying spines at their distal ends, and the terminal joint ending in three short spines of about equal length. The fifth legs are well defined and their setæ show beyond the edge of the genital segment.

Total length 7 mm. Length of carapace 4 mm.; width of same 3.25 mm.; length of genital segment 2.1 mm.; length of abdomen 0.5 mm.; length of egg strings 6.3 mm.

Color a uniform light yellowish white.

(*parviventris*, *parvus*, small, and *venter*, the abdomen.)

Male.—Carapace elliptical, one-eighth longer than wide, the posterior sinuses very broadly triangular, leaving a well-rounded median lobe and lateral lobes, which flare outward.

Free thoracic segment considerably narrower than the genital seg-

ment (seven-tenths of it). Genital segment ovate, one-third the width of the carapace, longer than wide, and quite squarely truncated posteriorly. There are two pairs of blunt papillæ projecting backward from the posterior portion of the lateral margins of this segment. The abdomen is quadrangular in outline, wider than long; the anal laminae are very long, while the plumose setæ which they carry are nearly as long as the entire abdomen.

Total length 4.5 mm. Length of carapace 2.8 mm.; width of same 2.4 mm.; length of genital segment 0.8 mm.; length of abdomen 0.4 mm.

This species closely resembles *L. hippoglossi* (Krøyer) and *L. appendiculatus* (Krøyer), of the latter of which only the male is known. But in both these species the branches of the furca are bifid and close together, while the general proportions of the body and its parts are also entirely different.

The National Museum collection includes several lots of this species taken during the voyage of the United States Bureau of Fisheries steamer *Albatross* in 1888. They are all from the northern Pacific, a portion of them on the American side and the rest on the Asiatic coast. From Humboldt Harbor, Shumagin Islands, Alaska, an unnumbered lot containing twenty females and ten males, no host given. From Loring Harbor, Alaska, an unnumbered lot taken from the cod of that region, *Gadus macrocephalus*.

From Chignik Bay, Alaska, another unnumbered lot; also from the cod, *Gadus macrocephalus*. From the Commander (Kommandorski) Islands, Siberia, ten females and one male taken from *Pleurogrammus monopterygius* (Pallas). From a halibut taken off Alaska in the summer of 1880, an unnumbered lot of ten females. From station No. 4212 of the United States Bureau of Fisheries steamer *Albatross* an unnumbered lot taken from a species of *Lepidopsetta*.

No specimens of the *Caligus curtus* or *C. rapax* were obtained from these Pacific cod, as it seems practically certain would have been done had those species been found there.

It would seem, therefore, as if this new species of *Lepeophtheirus* took the place on the Pacific cod occupied by the two species of *Caligus* on the Atlantic cod.

LEPEOPHTHEIRUS BIFURCATUS, new species.

Plate XXIII, figs. 285-293.

Female.—Carapace elliptical, distinctly longer than wide, and about one-third longer than the rest of the body. Frontal plates well defined with a shallow incision at the center.

Posterior sinuses broad, well rounded, and slightly inclined away from the central axis, leaving a median lobe considerably less than half the entire width and projecting well back of the lateral lobes. The latter are broad and well rounded.

Thoracic area considerably smaller than the cephalic and somewhat angular; digestive glands prominent, shaped like a comma, with the convex sides toward each other.

Free segment short and narrow, about one-fourth the width of the carapace, the bases of the fourth legs projecting strongly on either side. Genital segment ovate, considerably more than half as wide as the carapace, and three-fifths as long, with smoothly rounded corners and a slightly emarginate posterior border. Abdomen very small, wider than long, with small, widely separated papillæ. Egg tubes about the same diameter as the abdomen and short, only a trifle longer than the genital segment, each containing but twenty eggs.

Of the appendages the anterior antennæ are stout, the two joints about the same length; the posterior antennæ have a large basal joint supplemented by a short and stout accessory spine, while the terminal joint is long and abruptly bent.

The first maxillæ are very large for a female, strongly curved and blunt at the tip. The second maxillæ are also very large, cut about to the center, the branches thick and stout, and flanged along either side. These branches are widely separated at their bases and diverge considerably, giving the intervening sinus a deep basin shape. The distance from tip to tip of the branches is the same as the entire length of the maxilla.

The proboscis is long and of medium width, with nearly parallel sides. The first maxillipeds are long and slender; the terminal joint carries a small flattened spine on its anterior border at about the center. The two terminal claws are very uneven in length and both have serrated flanges along their sides. The second maxillipeds are small and rather weak; the terminal claw is a little more than half the length of the basal joint and strongly curved, with a small and weak accessory spine on its inner margin.

The furca is very large and wholly unlike that of any other known species. It is almost as wide at the tip as it is long, but is contracted to less than half that width at the base, giving the entire appendage somewhat the shape of a thick-stemmed wineglass. The sinus between the branches reaches nearly to the center and has a broad U shape, with the sides parallel.

The secondary branches are narrow and acuminate, and the sinus between them is triangular and cut in as deeply as the central one. It thus differs markedly from the furca of *hippoglossi* and *appendiculatus*, the only other species in which the furca is doubly bipartite. In *hippoglossi* the central sinus is triangular and its sides approach each other rapidly and almost touch at the tips. The secondary branches are laminate and squarely truncate at the ends. In *appendiculatus* the secondary sinuses are not more than a very small fraction of the length of the central sinus.

The first swimming legs of this new species are short and thick, the basal joint with a short spine at the distal end, the terminal joint with the usual spines and setæ.

The second and third legs are slender but otherwise like those in other species. The fourth legs are large and stout, four-jointed, the basal joint somewhat swollen and as long as the other three, with a plumose seta at its distal end on the outer margin. The second joint has a very short and strongly curved claw at its tip; the third joint has a much longer one, while the three terminal claws are still longer and increase in size from without inwards. The last four claws are close together and they all have serrate flanges along their outer margins. At the base of each of the claws on the dorsal surface is a large semicircular lamina made up of radiating thread-like spines, connected by a membrane. The tips of the spines project beyond the edge of the membrane, giving it a serrated appearance. The fifth legs are small and are not visible dorsally.

Total length 4.8 mm. Length of carapace 2.7 mm.; width of same 2.4 mm.; length of genital segment 1.6 mm.; length of abdomen 0.3 mm.; length of egg cases 1.7 mm.; twenty eggs in each case.

Color, a dark-brownish yellow, without pigment spots.

(*bifurcatus*, forked or divided into two branches, i. e., with a double furca.)

There is but a single lot containing two females of this new species, and the male is unknown. They were taken from one of the common flounders of the Pacific coast, *Psettichthys melanostictus*, in San Francisco Bay, California.

This species is distinguished from all others by the peculiar structure of the furca, as already noted. The wide separation of the branches of the second maxillæ is another distinguishing characteristic, the sinus between the branches being very much broader than in any known species. The fourth legs furnish a third character in the prominent spiny lamellæ at the bases of the claws. So far as known these are not present in any other species of the genus. There is but a single female with egg cases from which to diagnose the species, but everything about them seems to point to a very small number of eggs. The thickness of the eggs for any species does not vary appreciably, whether many or few have been extruded, and in this species they are much thicker than ordinary. In fact, the only other species which approaches it in this respect is *dissimulatus*, which has just been described.

LEPEOPHTHEIRUS SALMONIS Kröyer.

Plate XXIV.

Caligus salmonis KRÖYER, 1838, p. 13, pl. vi, fig. 7 a-e.

Caligus respa MILNE-EDWARDS, 1840, p. 456.

Caligus stromii BAIRD, 1847.

Lepeophtheirus salmonis BAIRD, 1850, p. 274, pl. xxxii, figs. 8 and 9.—KRÖYER, 1863, p. 137, pl. xvii, fig. 1 a-b.—RATHBUN, 1884, p. 487.

Lepeophtheirus stromii BAIRD, 1850, p. 274, pl. xxxii, figs. 8 and 9.—BASSETT-SMITH, 1899, p. 455.—T. SCOTT, 1900, p. 152, pl. vi, figs. 3 to 8.

Female.—Carapace orbicular, as wide as long; frontal plates narrow and not well defined; posterior sinuses narrow, shallow, and somewhat inclined away from the median line. Median lobe broad and well rounded, projecting but little beyond the lateral lobes, and often raised posteriorly into a fold or wrinkle, which projects over the dorsal surface of the free segment and hides it.

The grooves separating the carapace areas are well defined; the cross-bar of the "H" is strongly curved, so that it makes a continuous half circle with the lower portion of the sides. The free segment is very short and narrow, less than half the width of the genital segment. The latter is nearly as large as the carapace, fully as long but a trifle narrower, with well-rounded lobes projecting posteriorly on either side of the abdomen. The abdomen is four-fifths as long as the genital segment and narrow, with a clearly marked constriction near the posterior end. Such a constriction is usually good evidence of segmentation, but the most rigid examination of the opaque preserved specimens at the author's disposal fails to confirm the segmentation. It is quite possible, however, that living specimens would show it clearly, and for that reason the present species has been included twice in the artificial key herewith presented. The anal laminae are enlarged considerably at the tips and curved in toward each other.

The egg strings are fully three times as long as the entire body, and at the same time very narrow, which of course emphasizes their elongate appearance.

Of the appendages the second antennae are stout, with the terminal hook considerably longer than the basal joint; the latter also lacks a spine on its posterior margin.

The first maxillae are very long and stout, the basal portion swollen to about twice the diameter of the terminal curved part.

The second maxillae are of the usual size and shape. The first maxillipeds are stouter than usual, the terminal joint more than twice the length of the basal. The shorter terminal claw is about three-fifths the length of the longer one, and is dentate along its outer margin. In the second maxillipeds the terminal claw is only about half as long as the basal joint, and in all the specimens examined it lacked an accessory spine on the inner margin. The furca is proportionally small,

with short and blunt branches, which are somewhat divergent. The first swimming legs are short and stout; the basal joint has a short spine at its distal posterior corner, while the second joint has a similar one at the distal anterior corner. The terminal claws are nearly the same length, and the plumose setæ on the posterior margin are uncommonly large. Second and third legs as usual. The fourth legs are four-jointed, with four spines; the second joint has an enlarged tip, with rough papillary elevations, but without a spine. The third joint has a short spine, about as long as the two outer ones on the terminal joint. The fourth or inner terminal spine is fully twice as long as the others. The fifth legs are broadly triangular and terminated by three small spines, but are not visible from the dorsal surface.

Total length 18.2 mm. Length of carapace 6.6 mm.; width of same 6.6 mm.; length of genital segment 6.6 mm.; length of abdomen 5 mm.; length of egg strings 53 mm.; total length including egg strings 65 mm.

Color a dirty yellow brown, the dorsal surface often having a strongly metallic luster, quite different from any other species of this genus.

(*salmonis*, pertaining to the salmon.)

Male.—Carapace elliptical, one-third longer than the rest of the body, and one-fifth longer than wide. Frontal plates distinct, but not very wide; carapace areas as in the female.

Posterior sinuses much broader than in the female, but shallow and leaving the median lobe projecting well beyond the lateral lobes. Free segment long and narrow, only five-sevenths as wide as the genital segment, and swollen at the center through the bases of the fourth legs.

Genital segment elliptical-oblong, slightly narrowed anteriorly and with a shallow emargination on the posterior border, leaving very short and blunt lobes on either side.

Abdomen oblong, a little wider posteriorly, made up of two segments the basal of which is only about one-third as long as the terminal. Anal laminae very large, more than two-thirds as long as the terminal joint and broadly foliaceous, each carrying four long plumose setæ.

There is the usual sexual difference in the appendages, but nothing worthy of special note save that the fifth legs are not visible any more than in the female.

Total length 6 mm. Length of carapace 3.45 mm.; width of same 2.9 mm.; length of genital segment 1.1 mm.; length of abdomen 1.25 mm.

This species was first described by Krøyer in 1838 under the genus *Caligus*, and again in 1863 as a *Lepeophtheirus*, adopting Nordmann's

separation of such species as had no lunules. It was also described independently by Baird in 1847 under the name *Caligus stromii*, which he changed in 1850 to *Lepeophtheirus stromii*. This name of Baird's is the one subsequently retained by Bassett-Smith and T. Scott, the former of which gives Kröyer's name as a synonym under it.

But if the two species are identical, as there seems to be no doubt, then Kröyer's name has a priority of nine years over Baird's, and must be retained.

The species is common upon the salmon of our coasts as well as those of European waters, and often attains a large size.

Some of the females examined by the author measured 22 mm. in length, and that, too, although they had been preserved in alcohol. They can be readily distinguished from other species by the extreme length and slenderness of the egg strings and by the metallic luster so common on the dorsal surface.

The males are very scarce, the material in the entire National Museum collection yielding but a single specimen. So far as known, no figure of the male has ever been published previous to the one here included. The following are the lots in the National Museum collection: Cat. No. 8030, from salmon at the Tyne, England, used for identification of the American specimens. No. 8109, four specimens, including the single male from the gills of a salmon, locality not given. No. 8117, from the king salmon at Kenai, Alaska. No. 8489, fifteen specimens, from Ungava, Labrador, found on "salmon and sea trout." No. 12666, from salmon at St. Johns, Newfoundland. No. 36073, from salmon at East Orland, Maine. No. 41840, two specimens, from "Dolly Varden trout" in Alitak Bay, Alaska. No. 6017, from *Onchorhynchus gorbuscha* at Port Chatham, Cooks Inlet, Alaska. An unnumbered lot, from *Salmo salar*, found at Rigolet, Labrador.

The salmon at East Orland, Maine, must have been from fresh water, and several of the other species mentioned occur as entirely landlocked forms in various localities. There can be very little doubt, therefore, that this parasite is another instance of one which can remain upon its host during the passage of the latter from salt to fresh water. It would be of great interest to ascertain whether it remains upon such forms as have become entirely landlocked.

LEPEOPHTHEIRUS PACIFICUS Gissler.

Plate XXV, figs. 304-310.

Caligus pacificus GISSLER, 1883, p. 885, figures in the text.

Female.—Carapace about half the entire length, elliptical, a little longer than wide; frontal plates short and narrow, but well defined. Posterior sinuses wide and shallow, leaving a broad median lobe, more than half the entire width, and not projecting back of the lateral lobes. Thoracic area relatively small and well rounded posteriorly;

eyes small and situated far forward in the carapace. Free segment short and narrow. Genital segment quadrilateral, wider than long, widest and somewhat emarginate posteriorly; lobes very short and well rounded.

Abdomen only one-fourth the width of, but slightly longer than, the genital segment, and indistinctly four-jointed. It is cylindrical in form and tapers somewhat toward the tip; the joints also diminish regularly in length, the basal one being about twice the length of the terminal. The anal laminae are large and leaf-shaped, but armed with short setae.

The egg strings are two-thirds as long again as the entire body, of medium width, and there are between sixty and seventy eggs in each.

The first antennae are short and inconspicuous, with the two joints about the same length; the second antennae are stout, the basal joint short and wide, and tapering rapidly outward. This joint is provided on its inner surface with a knob-like process of chitin, the surface of which is raised into parallel transverse ridges, overlapping one another. There is thus formed a file-like surface which assists materially in the prevention of slipping. The terminal claw of this second antenna has a long slender spine on its outer margin. The mandibles are three-jointed, the third joint curved in toward its fellow and toothed along its inner margin.

The second maxillae are triangular and bifurcate for about one-third of their length; the branches are narrow and sharp while the basal portion is wide and strong.

The first maxillipeds are very slender, the terminal joint much longer than the basal and armed with a short, sharp spine on the inner margin near the center. The two terminal claws are not as uneven as in many species and both are bordered with a "delicate pectinate membrane" (Gissler). The second maxillipeds are large and stout, the basal joint considerably longer than the terminal claw. The accessory spine on the latter is near the base. The fourth swimming legs are short and weak, four-jointed with five spines, the basal joint as long as the other three, which latter are widened toward the tip.

The spine on the second joint is short and strongly curved, the other four spines are about equal and arranged in a row at the tip of the last joint. This is due to the fact that the second spine at the tip of the third joint is carried out by the elongation of the joint to a level with those on the terminal joint.

Total length 9.5 mm. Length of carapace 4.6 mm.; width of same 4 mm.; length of genital segment 2.4 mm.; length of abdomen 2.5 mm.; length of egg strings 15 mm.

Color dark rufous on the dorsal surface, lighter below.

(*pacificus*, of or belonging to the Pacific.)

Twenty-three females of this species were obtained by Gissler from

a salmon (probably the "blue-back salmon," *Oncorhynchus nerka*) inhabiting Puget Sound, on the Pacific coast.

They were described by him as a new species.^a He called the species a *Caligus*, but that does not seem possible after a careful study of his description and text figures.

There are no lunules on the frontal plates and the second maxillæ are bifurcated for one-third of their length, both of which are characteristics of the genus *Lepeophtheirus* as distinguished from *Caligus*.

From correspondence with Gissler it was ascertained that his type specimens had been turned over to the American Museum of Natural History at New York City. Dr. H. C. Bumpus, the director of the museum, very kindly made a careful search for the specimens at the author's request, but they could not be found. The species will have to stand, therefore, upon the original figures and description given by Gissler. Fortunately, these were carefully made and give us definite data to work upon. Nearly everything in the present account and the figures which are herewith presented were taken from Gissler. The species can be readily distinguished by the four-jointed abdomen; no other species in this genus has more than two joints in the abdomen. However, Gissler states that the segmentation is indistinct in fresh material, and only becomes distinct on being treated with acetic acid.

There may be a suggestion in this that some species, like *salmonis*, just described, in which the abdomen has been hitherto regarded as unsegmented, would show a distinct segmentation if treated in the same way with acetic acid.

The species bears some resemblance to *salmonis*, but the size and shape of the genital segment are entirely different, as are the details of every one of the appendages given by Gissler, particularly the second antennæ and the fourth legs.

LEPEOPHTHEIRUS COSSYPHI Kröyer.

Plate XXV, figs. 311-313.

Lepeophtheirus cossyphi KRÖYER, 1863, p. 115, pl. VII, fig. 6, a-e.—BASSETT-SMITH, 1899, p. 454.

Female.—Carapace longer than the rest of the body (as 7 to 4), nearly as wide as long, narrowed anteriorly. Frontal plates medium size, not well defined, without any emargination at the center. Free segment very narrow and short, considerably less than one-fourth as wide as the genital segment.

Genital segment half as long as the carapace, a little wider than long, of a broad acorn shape, squarely truncated posteriorly. The corners are well rounded, and to them are attached the long and slender fifth

^a American Naturalist, August, 1883, p. 885.

legs. These are conical and three-jointed, with a seta at the end of the first and second joints.

The abdomen is rudimentary, only one-eighth the length of the genital segment, and looking like a knob on its posterior border.

Anal laminae proportionally large, longer than the abdomen, as wide as long, with stout setae three or four times the length of the laminae. Egg strings not present.

Joints of the first antennae of about the same length and slender; second antennae of medium size and the usual shape.

First maxillae small and placed close to the second antennae, the base swollen more than usual, so that they appear two-jointed.

Proboscis small and plump, of the same length and width, and squarely rounded at the end. Second maxillae the same length as the proboscis, tolerably stout; the branches pointed and weakly curved. Eyes small and circular.

First maxillipeds of the usual form; second pair not as large as usual, and lacking the accessory spine on the terminal claw.

Furca small, the base squarely truncate, almost rectangular; the foramen tolerably large and of about the same length and width. Branches not as long as the base, simple, divergent, and pointed, the sinus between them triangular, with the sides almost meeting anteriorly. Rami of the third legs close together, but pointing straight backward. Fourth legs elongate, four-jointed, the basal joint as long as the three terminal ones.

There are five spines, of which those on the second and third joints are equal and of medium size, while of the three terminal spines the middle one is more than twice the length of the other two.

Total length 3.35 mm. Length of carapace 2.1 mm.; width of same 1.8 mm.; length of genital segment 1.1 mm.; length of abdomen 0.125 mm.

Color not given.

(*cossyphi*, the generic name of its host.)

Kröyer bases this new species upon a single female taken from the gills of the Spanish ladyfish or hogfish, *Harpe rufa*, in the West Indies. But although thus confined to a single specimen, the species presents well-defined characters which serve to distinguish it from all others.

The first of these characters is the relative proportion of the various body regions. The carapace and genital segment are noticeably large, while the free segment and the abdomen are equally small. The genital segment is also of a peculiar shape, and the fifth legs are unusually prominent.

But the crowning mark of distinction, if we may believe Kröyer's statement, is the fact that these fifth legs are indistinctly three-jointed. In no other known species of *Caligus* or *Lepcophtheirus* is there any

indication of jointing in these appendages. We thus have here a form in which the fifth legs are less rudimentary than usual, and one which leaves no possible doubt as to their morphological significance.

LEPEOPHTHEIRUS ROBUSTUS Kröyer.

Plate XXV, figs. 314, 315.

Lepeophtheirus robustus KRÖYER, 1863, p. 135, pl. VI, fig. 6 a-c.—BASSETT-SMITH, 1899, p. 456.

Male.—Carapace longer than the rest of the body, the proportion about 5 to 2 and strongly arched. Frontal plates weakly developed and not very distinct. Free segment quadrangular in form with rounded corners, a little contracted anteriorly.

Genital segment about one-fourth as long as the carapace, and of the same width and length. On either side anteriorly there is a fold of skin which fills up the space between this segment and the one in front of it. The posterior corners are squarely rounded and the fifth legs appear as stout pointed knobs armed with three or four long setæ.

The abdomen is half as long as the genital segment and of about the same width and length. The anal laminae are one-fourth as long as the abdomen and a little wider than long. They are armed with setæ which are at least four times as long as they are themselves, and with tufts of hair on either side at the base of the setæ.

The first antennæ are short, with the basal joint somewhat plump and longer than the second joint. In the second antennæ the terminal claw is particularly long and sharp.

The first maxillæ are quite stout, while the second are larger still, and are deeply cleft at the tip into two acuminate branches. The proboscis is plump, not quite twice as long as wide. The first maxillipeds are weak, the inner terminal claw fully twice as long as the outer. The second pair are proportionally larger but with a short terminal claw.

Furca small and somewhat difficult to see; base longer than the branches, squarely truncated anteriorly, with a slender frame and a large, half-moon-shaped foramen. The branches are short and plump and cleft at the ends; the secondary branches are very short, the outer one much wider than the inner, and turned outward, while the inner one points straight backward.

First swimming legs short and stout, the second joint plump and egg-shaped, with a spine and a rounded protuberance on its anterior border. Second swimming legs characterized by their stoutness; rami of the third legs small and close together. Fourth legs small but stout, four-jointed, with the basal joint as long as the other three; the latter decrease regularly in size in the proportion of 4, 3, and 2. There are only four spines, the second joint ending in an enlarged and

papillated prominence instead of a spine. Of the three terminal spines the outer, which is the smallest, has a peculiar knife-blade shape.

Total length 7.875 mm. Length of the carapace 5.5 mm.; width of the same 4.3 mm.; length of genital segment 1.45 mm.; length of abdomen 0.75 mm.

Color not given.

(*robustus*, stout, strong.)

This species was founded by Krøyer on two male specimens obtained from a species of *Raja* off the Greenland coast. It is not as well defined as the preceding species, but seems fairly well characterized by the skin protuberances on the genital segment and by the bipartite furca.

Genus ANURETES Heller.

Carapace large and shield-shaped, as in the preceding genera. Frontal plates well defined, without sucking disks. Second maxillæ small, simple, and straight. Second maxillipeds large and very powerful. First and fourth thoracic legs uniramous, second and third biramous, the rudiments of the fifth pair large and prominent. Genital segment large, well rounded, emarginate posteriorly. Free thorax segment small and without dorsal plates. Abdomen entirely lacking, the anal laminae only left, attached to the ventral surface of the genital segment. Egg strings as in *Caligus*.

(*Anuretes*, *av* primitive, *ovpa*, tail.)

KEY TO THE SPECIES.

- Genital segment semilunar, deeply cut posteriorly; fourth legs small, three-jointed, four spines close together at tip.....*heckelii*, p. 647.
Genital segment almost circular, with shallow, triangular posterior depression; fourth legs long, first spine removed some distance from the others.....*perplexus*.

ANURETES HECKELII Krøyer.

Plate XXV, figs. 316-321.

Lepeophtheirus heckelii KRØYER, 1863, p. 110, pl. VII, figs. 4, a-h.

Anuretes heckelii HELLER, 1865, p. 186.—BASSETT-SMITH, 1899, p. 457.

Female.—Carapace somewhat longer than the rest of the body, about as wide as long. Frontal plates distinct, but narrow and only slightly emarginate at the center. Posterior sinuses broad and shallow; median lobe about half the entire width, projecting scarcely at all beyond the lateral lobes.

Free segment narrow and proportionally long with almost parallel sides. Genital segment two-thirds as long as the carapace and three-fourths as wide, its sides strongly curved and projecting backward at the corners as a pair of stout papillæ, representing the fifth legs. Between these papillæ the posterior border of the genital segment is slightly convex, but the projecting papillæ give this border a deeply

emarginate appearance. Abdomen entirely lacking, or only appearing in the faintest traces on the ventral surface of the genital segment. Anal laminae as in other genera, not at all degenerate, but attached to the ventral surface of the genital segment owing to the absence of the abdomen. Their exact position varies considerably in different specimens, but they are usually attached some little distance in front of the posterior border. For this reason they are wholly, or almost wholly, concealed in dorsal view, only their tips or the setae attached to them appearing beyond the edge of the genital segment.

First antennae small and plump, the joints about even and armed as in other genera; second pair with a large terminal claw bent at a sharper angle than usual.

First maxillae rather large and plump, not much swollen at the base; second pair little more than half as long as the mouth tube, separated from it quite a distance on either side, simple and pointed, with a greatly enlarged base.

Mouth tube large, twice as long as wide, and well rounded at the end. Eyes small, situated posterior to the base of the mouth tube, the lenses separated by about twice their own diameter. First maxillipeds with a blunt lobe on the middle of the inner margin of the terminal joint. Second pair very large and strong, the basal segment much swollen but without knobs or spines, the terminal claw stout, bent abruptly, and without any accessory spine on the inner border.

Furca small, plump, the basal part slightly longer than the branches, with a membranous frame and large oval foramen.

The branches are simple, parallel and club-shaped, with obtuse ends; the sinus between them is long and very narrow.

There is no spine at the distal corner of the terminal joint of the first thoracic legs, but only the three terminal claws, the longest of which is about the length of the joint.

Second swimming legs as in *Caligus*. Third pair different from the genera already described; the basal laminae are larger and the rami are not attached to their posterior border or at the posterior corners, but high up on the lateral borders and close together so that they partially overlap.

Furthermore the endopod consists of but a single segment, armed with three strongly curved bristles which hardly deserve the name of plumose setae. The exopod is two-jointed and but scantily armed. The fourth legs are small but comparatively strong, three-jointed, the basal joint as long as the other two. There is a spine at the end of the second joint and three on the terminal joint, all so close together as to form a single bunch or cluster.

The fifth legs appear as a pair of very stout and long papillae projecting from the posterior corners of the genital segment, each ending in a single stout spine.

Total length 2.8 mm. Length of carapace 1.53 mm.; width of same 1.6 mm.; length of genital segment 1 mm. Egg strings wanting.

Color not given.

(*heckelii*, to Prof. Ernst Hëckel.)

This species was founded by Kröyer upon three specimens, all females, two of which he obtained from the Vienna Museum while the third came from Biloxi, near New Orleans, on the shore of the Gulf of Mexico. The two Vienna specimens were said to have been found by Hëckel on the gills of an *Ephippus gigas* from the Brazilian coast. They had been labeled by Kollar *Caligus heckelii* and Kröyer retained the specific name of the label but changed the genus. The North American specimen was found on the gills of the same fish (the angel-fish or spadefish, *Chætodipterus faber*, Broussonet).

This is the only representative of the genus found in North American waters and may be recognized by the entire absence of the abdomen.

NONAMERICAN SPECIES.

The collection of the National Museum includes specimens of the following species, which have not thus far been found in North American waters. Three of the species are new to science and one of them is made the type of a new genus.

CALIGUS TERES, new species.

Plate XXVI.

Female.—Carapace one-fourth longer than the rest of the body, about the same length and width, and very strongly ovate in shape, the posterior portion being more than twice as wide as the frontal plates. The latter are well differentiated, with large, almost circular lunules which project strongly in front of the antennæ. The posterior sinuses are wide and comparatively deep, leaving a median lobe about half the entire width and projecting considerably behind the lateral lobes. The sinuses are slightly inclined away from the mid line, and the posterior margin of the median lobe is a little concave.

The lateral lobes are broad and well rounded, their thoracic portion being very prominent and projecting considerably behind the rest of the lobes. Thoracic area large and well rounded, embracing half the length and fully two-thirds the width of the carapace. The crossbar and the lower portion of the sides of the "H" make a nearly perfect semicircle.

The free thorax segment is almost half as long as the genital segment, and is strongly narrowed in front of the bases of the fourth legs, leaving the sides concave.

The genital segment has a broad, barrel shape, with evenly rounded sides; it is two-fifths the length of the carapace, as wide as it is long,

with an emarginate posterior border and short, well-rounded lobes. The abdomen is three-fifths the length of the genital segment, and like the latter has a broad, barrel shape, abruptly narrowed into a neck, where it joins the genital segment.

The anal laminae are large and foliaceous, separated more than their own diameter, and armed with large and stout setae.

The egg tubes are about half as long as the body; each has a diameter a little more than half that of the abdomen and contains 60 eggs. The anterior antennae are of medium size and very heavily armed with setae and spines; the posterior pair have a stout basal joint and a long, slender terminal hook. The accessory spines situated just posterior to the base of these antennae are small and weak.

The first maxillae are of medium size, slightly curved, and considerably enlarged at the base; the second pair are large and stout, as long as the proboscis, and abruptly curved near the base.

The terminal portion is nearly straight and ends in a rather blunt point. The terminal joint of the first maxillipeds is much longer than the basal and is tipped with two long and curved claws, the inner of which is longer than the outer, and has a serrate lamina along its anterior and posterior margins. There is also a stout curved spine upon the anterior margin of this terminal joint near its distal end.

The second maxillipeds are large and stout, the terminal claw about half the length of the swollen basal joint, with a long accessory spine upon its inner margin close to the tip.

The inner margin of the basal joint is also raised into a slight protuberance just opposite the point of the claw.

The furca is narrow, the base as long as the branches and slightly swollen; the branches are straight, almost parallel, and acute. The three terminal claws on the first swimming leg are long and strongly curved, decreasing in size from the anterior to the posterior. There is no seta at the distal corner, but the three plumose setae on the posterior margin are of the usual size. The second legs are noticeable chiefly for the spines on the exopod and the curious shape of its terminal joint. There are but two spines, one on the basal joint and one on the second joint; the former is about three times the length of the latter, and stretches across the second joint and projects beyond its inner border nearly a third of its length. The terminal joint of this exopod is shaped like the quadrant of an ellipse, the half of the shorter diameter joining the second joint, while the half of the longer diameter forms the anterior border. The plumose setae are arranged in a row around the curved posterior margin.

The rami of the third legs are well separated; the exopod has a stout basal joint with a medium-sized claw, and a considerably smaller terminal joint, both joints being appressed closely to the margin of the apron. The fourth legs are long and slender, three-jointed with five

spines, of which three are terminal. The outer of these terminal three is rudimentary and so small as to be easily overlooked. The tips of the legs slightly overlap the abdomen, the basal joints, which are the same size throughout, being about as long as the two terminal joints. On the outer margin of the basal joint near the distal end is a short plumose seta; there is a large spine at the distal end of the second joint, and one on the outer margin of the terminal joint at about its center. At the bases of this last spine and also of each of the three terminal spines there is on the ventral surface a small lamina whose edge is cut into very long and acuminate teeth. The fifth legs are so small as to be wholly invisible dorsally and they can be seen on the ventral surface only with difficulty.

Total length 4.75 mm. Length of carapace 2.6 mm.; width of same 2.75 mm.; length of genital segment 1 mm.; length of abdomen 0.7 mm.; length of egg strings 2.2 mm. Sixty eggs in each.

Male.—Carapace three-fifths of the entire length, and proportionally narrower posteriorly than in the female, but wider anteriorly.

Frontal plates wider and more prominent, and the lunules larger. The eyes appear a little farther back in the carapace, owing to the width of these frontal plates.

Thoracic area as large as in the female and rounded similarly. The glands in this area which show as dark masses through the dorsal integument are of peculiar shape and very similar in the two sexes. Each consists of a large ovate posterior portion and a smaller elliptical or spherical anterior portion, the two being connected by a narrow neck. On the inner side both portions of these glands are flattened against the intestine and present a nearly straight line for their entire length.

The free segment is longer and wider than in the female, and is similarly constricted in front of the fourth legs. It is fully as wide as the genital segment and overlaps the anterior end of the latter on either side by the width of the basal joint of the fourth legs.

The genital segment is oblong, narrowed considerably anteriorly where it joins the free segment, and has a convex posterior margin. On either side near the posterior end is a broad and blunt triangular spine, on the ventral side of which may be found the fifth legs.

The abdomen is about two-thirds the width and seven-eighths the length of the genital segment, two-jointed, the basal joint considerably the smaller, with a strongly convex posterior margin.

The abdomen widens a little posteriorly and the anal laminae are set into the sides as much as the end of the terminal joint. They are very large and foliaceous, but the plumose setae upon them are not much larger than those of the female.

The appendages are very similar to those of the female, the chief differences being in the enlarged and branched second antennae, the

enlarged second maxillipeds, and the fourth legs. The latter have the same detail as in the female, but reach well beyond the posterior margin of the basal abdominal joint.

Total length 3.7 mm. Length of carapace 2.2 mm.; width of same 2 mm.; length of genital segment 0.7 mm.; length of abdomen 0.54 mm.

Color, a dark-brownish yellow, without pigment spots.

(*teres*, smooth, well rounded.)

The National Museum collection includes two lots of this species, one of twenty-five females and two males taken from a *Callorhynchus*, and the other of about the same number taken from a ray, both at Lota, Chile. The ray and the chimæra were in the same tub of fish, so that it is very possible the parasites may have crawled from one to the other. This is a very clean-looking species, and the roundness of its outlines gives it both grace and symmetry. It may be easily distinguished from other species by the rounded barrel shape of the genital segment and abdomen, and by the concave sides of the free segment. This preliminary diagnosis may then be verified by the presence of toothed laminae at the bases of the spines on the fourth legs.

In 1849 one Claudius Gay published what he styled *Historia fisica y politica de Chile*, which was issued at Madrid and contained, among other things, a review of the animal and plant life of the country. The author has been unable to find a copy of the text of this work, but in the volume of plates there is a figure^a of a parasitic copepod which is designated *Caligus gayi*. This was found upon an undetermined fish and resembles the present species in many particulars, but there is still enough difference, particularly in the coloration, to render it certain that the two are distinct species.

CALIGUS CENTRODONTI Baird.

Plate XXVII.

Caligus centrodoni BAIRD, 1850, p. 272, pl. XXXII, figs. 6 and 7.—BASSETT-SMITH, 1899, p. 447.

Female.—Carapace considerably more than twice the length of the rest of the body, and quite strongly narrowed anteriorly. Frontal plates large and distinct, with a deep central incision; lunules large, circular in outline, and not projecting much beyond the anterior margin. Posterior sinuses of medium depth, nearly parallel, and well rounded; median lobe a little more than half the entire width, and squarely truncate or slightly emarginate posteriorly. Thoracic area large and very well defined but with indistinct digestive glands.

Eyes situated far forward and entirely separated from each other but very close together, the axes slightly inclined toward each other anteriorly.

^aPlate III, fig. 12.

Free segment short and narrow, overlapped by the carapace anteriorly and by the genital segment posteriorly. From either side of this segment there projects over the base of the fourth leg a narrow, blunt plate or spine, about half as long as the basal joint of the leg. This overlying plate, together with the small size of the fourth legs, renders the latter invisible in dorsal view.

Genital segment transversely semilunar in shape, one-third wider than long, the sides well rounded, the posterior angles prolonged backward as stout blunt lobes. The posterior margin between these lobes is deeply concave, being fully one-third of the entire length. The fifth legs are not visible dorsally, but may be distinctly seen upon the ventral surface of the posterior lobes. The abdomen is so small as to be at least partially rudimentary. It is less than one-fourth the width of the genital segment and does not quite reach the level of the tips of the posterior lobes of the genital segment. In shape it is ovate, the base being contracted strongly and joining the genital segment on its ventral surface, a little anterior to its posterior margin. The genital segment thus overlaps and partially conceals the base of the abdomen.

The anal laminae are proportionally of good size, but armed with small setae. Egg cases about two-thirds as long as the body, and considerably wider than the abdomen, each containing thirty-five to forty eggs.

Of the appendages the anterior antennae are short, the two joints about the same length and not very heavily armed with setae and spines. Second antennae small and without any accessory spine at the base of the proximal joint.

First maxillae large and well curved, but with very little swelling at the base. Second pair simple, with a wide triangular base and a short blunt tip; they are attached opposite the base of the mouth tube and extend slightly beyond its tip.

The mouth tube is short and evenly rounded, nearly as wide as it is long. First maxillipeds of the usual form; second pair very small and weak, hardly larger than the first pair; the terminal claw is a little more than half the length, and considerably less than half the width, of the basal joint.

The tiny accessory spine is attached close to the distal end of the claw on the inner margin.

The first swimming legs are smaller than usual, with only one of the three terminal claws at all developed, the other two being rudimentary. The plumose setae on the posterior border of the terminal joint, however, are full size.

The exopod of the second legs has but two spines; the one on the first joint is large and stout, but the one on the second joint is rudimentary. The rami of the third legs are large and well separated,

but the exopod is turned sidewise and appressed so close to the margin of the basal apron that the latter overlaps it somewhat. This brings the tip of the exopod over onto the endopod, so that the two appear close together. The fourth legs are small and weak, three-jointed with four spines; the first and third joints are about the same length, the second joint is only one-third as long.

The spine at the tip of the second joint is long, slender, and perfectly straight; of the three at the tip of the third joint the inner one is very short and rudimentary; the outer one is about the same length as that on the second joint, and like it slender and straight. The middle claw is much larger, nearly as long as the joint itself and strongly curved.

Fifth legs as already stated.

Total length 4 mm. Length of carapace 2.7 mm.; width of the same 2.5 mm.; length of genital segment 1 mm.; length of abdomen 0.4 mm.; length of egg strings 3.5 mm.

Color a light yellowish brown without pigment spots.

(*centrodonti*, the specific name of its host.)

Male.—Carapace as in the female, but proportionally much larger (as 7 to 2); not narrowed as much anteriorly. Frontal plate larger and wider and lunules larger. The median posterior lobe is not quite as large proportionally and is slightly rounded along the posterior margin instead of being emarginate.

Free segment short and almost concealed beneath the carapace and the genital segment. It is proportionally much wider than in the female, and from tip to tip of the lateral plates is five-sevenths as wide as the genital segment.

The latter is narrower than in the female, but is of the same shape. The fifth legs show plainly at the tips of the posterior lobes. Abdomen relatively larger than in the female, with anal laminae almost as large as itself. The abdomen proper does not reach to the tips of the posterior lobes of the genital segment, but the anal laminae project well beyond them (fig. 344).

Of the appendages there is no increase in the size of the second antennae, as is usual, but there is enough increase in the second maxillipeds to more than compensate for this. Instead of the weak and puny appendages found in the female, the male carries a pair of enormous second maxillipeds.

The basal joint is swollen until it is fully as wide as long, and is armed on the inner margin with two large protuberances or papillae, into the sinus between which the tip of the terminal claw fits snugly. This basal joint is supplied with very powerful muscles, particularly the one which closes the terminal claw. The latter is three-quarters as long as the basal joint and stout.

The first maxillae are also very much enlarged, and are bent into a sickle shape, with a slightly enlarged base.

Total length 3.5 mm. Length of carapace 2.5 mm.; width of same 2.3 mm.; length of genital segment 0.9 mm.; length of abdomen 0.25 mm.

The collection of the National Museum contains one lot of this interesting species sent from England by Rev. A. M. Norman. It is numbered 8105, and was obtained from the gill cavity of *Pagellus centrodontus*. The species was originally discovered by Baird and described by him in 1850, and no further description has ever been given. Indeed, so far as known, it was not even noted by any other author until Bassett-Smith in 1899, and he simply gives the name.

The description here given supplements that of Baird in many particulars, especially with regard to the appendages.

Attention should be called to the lateral plates or spines on the sides of the free segment which are not mentioned by Baird, but which are important as a connecting link between this form and those in the following subfamily, the Euryphorinæ. The latter are characterized by the presence of just such plates in all the species, while the Caliginæ, which are here discussed, have no such plates or processes.

In the present species the plates are so small as to be easily overlooked, but if the large aprons at the bases of the second legs be removed and the copepod be then examined the plates appear plainly. Most of the Euryphorinæ are unable to swim about freely, and with this lack of free locomotion there appear the dorsal plates on the thorax, or abdomen, or both.

It is interesting to find that the beginnings of these plates are found among forms which still retain the ability, if not the disposition, to move about freely.

Another detail of anatomy is equally interesting, and this also was overlooked by Baird. The upper surface of the genital segment projects considerably over the base and sides of the abdomen, so that the latter is partially concealed in dorsal view. But the posterior margin of the genital segment is cut in a deep semicircle, which reveals most of the dorsal surface of the abdomen. We have here, therefore, the initial step in the disappearance of the abdomen; the genital segment is deeply incised to receive it, and it is attached on the ventral surface so as to be partly concealed. The second step is found in *Lepcophtheirus dissimulatus*, where the abdomen is attached as far forward on the ventral surface, but the genital segment is no longer incised, and consequently almost entirely covers the abdomen. The third and last step is the complete disappearance of the abdomen in the genus *Anuretes*.

LEPEOPHTHEIRUS INNOMINATUS, new species.

Plate XXVIII, figs. 345-352.

Female.—Carapace elliptical, one-eighth longer than wide, equally narrowed anteriorly and posteriorly. Frontal plates small, but well defined with a deep incision at the center.

Posterior sinuses shallow, narrow, somewhat enlarged at the base and inclined diagonally outward. Of the grooves separating the carapace areas that which represents the crossbar of the "H" is only two-sevenths of the length of the carapace from its posterior margin. Furthermore it is not curved, but is made up of two straight lines meeting at the center like the sides of a very flat roof. This leaves a thoracic area proportionally smaller than in any known species of either *Caligus* or *Lepeophtheirus*. The longitudinal grooves are strongly curved, so as to be practically parallel with the margin of the carapace. The eyes are situated well forward and are of good size. The median lobe of the carapace projects backward well beyond the lateral lobes; it is abruptly narrowed at about the center as if jointed, the posterior half being semi-circular and overlapping the free segment a little.

The latter is considerably more than half as wide as the genital segment; is quite short and somewhat crescentic in shape.

The genital segment is fully as large as the carapace, quadrangular in outline, with well rounded corners and a squarely truncated posterior margin. Anteriorly it narrows into a short neck, where it joins the free segment, the neck being considerably narrower than the free segment.

The abdomen is narrow cylindrical, about one-third the width of the genital segment, and nearly four times as long as wide. It is two-jointed, the basal joint three times the length of the terminal; the latter joint is also quite a little narrower than the former, but does not taper posteriorly. The anal laminae are of good size and curve in toward each other at their tips; the plumose setae are rather short and slender.

The egg strings are two-thirds as wide as the abdomen and five-eighths the length of the body; the eggs are small, eighty or eighty-five of them in each string.

Of the appendages, the first antennae are about as long as the frontal plates, the two joints of the same length, and well supplied with setae and spines. The second antennae are long and slender, the most of the length being in the terminal claw, which is strongly bent near the tip. The basal joint is short and stout. The two pairs of maxillae are small and slender, the second pair bifid for only a third of their length, with the branches parallel and close together.

The furca is small, the base and branches about the same length,

the former slightly enlarged where it joins the ventral surface, the latter of a broad U shape, with blunt points.

The second maxillipeds are enormous, the stout basal joints filling the whole central portion of the carapace; the terminal claws are nearly as long as the basal joint and are strongly curved near their tip. The accessory spine is small and weak and is attached near the base of the claw.

There are no spines on the first legs except on the terminal joint, where there are the usual three, and three plumose setæ on the posterior border. The three spines on the exopod joints of the second legs are the same size and all very sharp.

The rami of the third legs are close together, with a large spine at the base of the exopod. The fourth legs are long and stout, three-fourths the length of the genital segment.

The basal joint is nearly as long as the other three, exclusive of the claws. Of the latter there are five, a tiny, rudimentary one at the enlarged tip of the second joint, a somewhat larger one at the tip of the third joint, and three terminal ones.

These last are graded in size from without inward. The outer one is no larger than that on the second joint, the second one is three times as large, while the inner one is twice the size of the second and is toothed along its outer border.

The fifth legs are invisible dorsally, but are plainly discernible on the ventral surface.

Total length 9.2 mm. Length of carapace 2.8 mm.; width of same 2.5 mm.; length of genital segment 2.8 mm.; length of abdomen 3.2 mm.; length of egg strings 6 mm. Eighty to eighty-five eggs in each.

Color a dark steel gray, changing but little in alcohol.

(*innominatus*, without a name, the one given to it being preoccupied.)

The National Museum collection has a single lot of this species, numbered 8028, and including three females taken from a salmon at Cornwall, England, by the Rev. A. M. Norman.

These are labeled by Mr. Norman *Lepeophtheirus gracilis*, but that name can not stand, for several reasons. In the first place, P. J. van Beneden described, in 1851, a species which he called *Caligus gracilis*, but which was really a *Lepeophtheirus*. If any species of the genus were to preserve the name *gracilis*, it would of necessity be this one. But even a casual glance at Beneden's figure will suffice to show that he was really describing something very different from the present species.

Again, Beneden's species has been shown by various authors to be the same as *L. thompsoni* Baird, and hence must be included under the synonyms of that species. Therefore it could not stand for the present species, an entirely different form.

For these reasons we have considered it necessary to change Norman's label, which has never been published, and leave *L. gracilis* in its old place as a synonym of *L. thompsoni*.

Under the latter species will be found (see p. 622) a full discussion of these troublesome synonyms. It will suffice here to state that the present species can be distinguished at once from *L. thompsoni*, with which it is most likely to be confused, by the equality in size between the carapace and genital segment, by the comparative length of the abdomen (considerably longer than either carapace or genital segment), and by the large size of the second maxillipeds. In the present species, also, the basal joint of the fourth leg reaches well beyond the margins of both carapace and genital segment, while in *thompsoni* the entire leg, if straightened out, would not reach the margin of the carapace, and the basal joint falls far short of reaching the margin of the genital segment. Finally, the present species was found on a very different host.

LEPEOPHTHEIRUS CHILENSIS, new species.

Plate XXVIII, figs. 353-364.

Female.—Carapace orbicular, as wide as long, the frontal margin strongly curved and deeply incised at the center.

Posterior sinuses shallow and widely triangular; median lobe about one-half the width of the carapace, and not projecting much behind the lateral lobes. Transverse groove separating the cephalic from the thoracic areas almost exactly in the center of the carapace; lateral grooves nearly straight.

Free thoracic segment short and less than half the width of the genital segment; very prominently widened at the center through the base of the fourth leg. Genital segment half the width of the carapace, one-fourth wider than long, with strongly curved lateral margins and somewhat reentrant posterior margin.

Abdomen half as long as the genital segment and one-fifth as wide, distinctly two-jointed, the joints about equal.

Anal laminae small and widely separated, curved in slightly toward each other and armed with small and short setae.

The anterior antennae are large, three-fourths as long as the frontal plates with the terminal joint shorter and much narrower than the basal. Both joints are heavily armed with setae, those on the terminal joint being gathered at the tip.

The posterior antennae are large, the basal joint swollen and with a good-sized spine on its ventral surface. The terminal claw of these appendages is strongly bent in a horizontal direction at the base, and again in the usual vertical direction at the tip. The first maxillae are close to the tip of these antennae, are of medium size, and nearly straight.

The second maxillæ are of about the same size as the furca and are cut beyond their center with divergent branches, of which the inner one is the larger and curved the more.

The first maxillipeds are of the usual form; the second pair are rather small, the basal joint more than twice the length of the terminal claw; the latter is weak and not much curved.

The furca is of medium size and cut beyond the center, making the branches longer than the base. The former are conical and widely divergent; the latter is swollen on either side at the center, giving a spindle shape.

The first swimming legs have a stout spine upon the outer and another upon the posterior margin of the basal joint. The terminal spines are nearly equal and not pectinate, while the plumose setæ are rather short. The second legs have large spines upon the outer margin of the exopod; the rami of the third legs are well separated and longer than in most species.

The fourth legs are large and stout, their tips reaching back beyond the genital segment. They are four-jointed, the basal joint only half as long as the other three, including the spines. This basal joint has a stout spine on its outer border at a little distance from the distal end. The third joint is longer than the second and fourth and ends in a short spine. There is no spine on the second joint. The terminal spines are strongly curved and vary much in length, the inner one being nearly three times the length of the outer.

The fifth legs are large and prominent and project beyond the posterior margin.

In young females the free segment and genital segment and abdomen are each of nearly the same size, the fourth segment being the widest and the others narrowing slightly in order. The fifth legs project as very large papillæ from the posterior margin of the genital segment and are much more prominent than even in the adult male. There is no trace of segmentation in the abdomen, but this region is almost exactly like that in the adult male.

Total length 5.3 mm. Length of carapace 3.2 mm.; width of same 3.1 mm.; length of genital segment 1.2 mm.; length of abdomen 0.55 mm.; length of egg strings 3.3 mm.

Color a dull yellow with a slight tinge of brown, with no pigment spots visible in preserved specimens.

(*chilensis*, of or belonging to Chile.)

Male.—Carapace twice the length and more than four times the width of the rest of the body, its own length and width being about the same. Posterior sinuses the same as in the female, but the thoracic area is relatively smaller and the digestive glands are larger. The free segment is as wide as the genital segment, one-fifth the width of the carapace, and relatively longer than in the female. The fourth

legs are attached to its posterior lateral margins, which are much widened through their bases. The genital segment is oblong, with well-rounded anterior corners where it is contracted into a neck on joining the free segment. It carries two pairs of papillæ, one at the posterior corners and the other on the lateral margins just in front of those corners.

The abdomen is small, only half the length of the genital segment, as wide as long, with no trace of segmentation. The anal laminae are much larger than in the female and their setæ are very much longer and stouter.

The second antennæ are enlarged as usual in this sex into clasping organs, but the branches are reduced to mere knobs. The rami of the third legs are especially prominent and protrude a long distance from the margin of the basal apron.

The fourth legs are relatively much larger than in the female; the basal joints alone reach more than three-quarters of the length of the genital segment, while the tips extend well beyond the ends of the anal laminae.

Total length 3.3 mm; length of carapace 2.2 mm.; width of same 2.2 mm.; length of genital segment 0.58 mm.; length of abdomen 0.3 mm.

Color somewhat darker than in the female.

The National Museum collection includes three lots of this new species, all of which were obtained at Lota, Chile, during the voyage of the United States Bureau of Fisheries steamer *Albatross* in 1887-88.

The first two lots are numbered 1502 and 1503, while the third lot is unnumbered. No host is given for the first lot; the second, 1503, was taken from a ray, while the third was taken from a species of *Sebastes*. This third lot includes twenty-five females and two males, which are excellently preserved.

The species resembles *parviventris* at first sight, but is considerably smaller and the proportions of the various body regions are markedly different. This is seen especially in the general shape of the carapace and genital segment and in the relative size of the two.

The abdomen, also, in this species is relatively longer and is made up of two segments, while in *parviventris* it is shorter and undivided. The egg strings in *parviventris* are as long as the entire body, while here they are only three-fifths as long. In *parviventris* the furca has a broad U shape, the branches widely separate and parallel; here the furca is much smaller, V shaped, with the branches starting close together and diverging rapidly. In this species, also, the second maxillipeds are small and weak, while the fourth legs are very large and strong; in *parviventris* exactly the opposite is true.

Genus HOMOIOTES, new genus.

Carapace large and shield-shaped. Frontal plates without lunules. Mandibles with sharp sawteeth along the inner margins only. Second maxillæ small and divided as in *Lepeophtheirus*. First and fourth swimming legs uniramous, second and third biramous. Genital segment covered by a pair of dorsal plates which finally fuse into one. In the female this plate often grows forward and covers the free segment as well as the genital segment, overlapping the bases of the fourth legs. It extends backward to the center of the abdomen and on either side of the latter sends out a well-rounded, flattened lobe, terminating in a stout blunt spine which reaches even beyond the tips of the anal laminae. In the male the plate covers only the genital segment and does not quite reach the base of the abdomen. In this latter sex a pair of fifth and a pair of sixth legs are plainly visible on the genital segment, the former very well differentiated.

Abdomen unsegmented, without plates or processes; anal laminae small, flattened and armed with plumose setae.

(*Homoiotes*, *ὁμοιότης*, likeness or similarity.)

HOMOIOTES PALLIATA, new species.

Plate XXIX.

Female.—Carapace orbicular, as long as wide, much narrowed anteriorly and posteriorly. Frontal plates well defined but narrow, completely separated by a central incision, within which can be seen the remains of a frontal filament. Posterior sinuses narrow, of medium depth, and inclined outward, leaving a median lobe fully half the entire width and rather flatly rounded posteriorly. The lateral lobes are narrow, sharply rounded, and curved strongly inward. Thoracic area rather small, the groove which separates it from the cephalic area being made up of two straight lines inclined toward each other like the sides of a roof. The digestive glands in the center of the area show plainly and are semicircular in shape.

The free segment, seen from the ventral surface, is about half the width of the genital segment and less than a third as long. In the adult its dorsal surface is entirely covered by a mantle or lamina which overlaps the bases of the fourth legs on either side and extends back the entire length of the genital segment and half the length of the abdomen.

This lamina belongs really to the genital segment and grows forward over the free segment as can be seen in all young females, all males, and in several of the adult females, where the free segment is without any covering. It starts as a pair of small plates, one on either side at the base of the genital segment. These grow inward toward each

other, backward, and in the adult females usually forward, until they finally fuse into a single plate or lamina.

The genital segment, seen from below, is about half the width of the carapace, and is ovate in shape, narrowing rapidly toward the posterior end. The sides are very evenly rounded and the dorsal lamina which covers the entire upper surface projects considerably beyond the lateral margins, and extends backward on either side of the abdomen in a broad, flattened lobe. These lobes are about one-third the width of the lamina at the point where they arise and each is tipped with a stout spine. The sinus between them is deep and almost a perfect semicircle in outline, leaving exposed the terminal half of the abdomen. This latter is small, only one-fourth the length of the genital segment, and composed of a single joint. Its base is concealed beneath the posterior edge of the dorsal lamina, which covers both the free and genital segments, and it tapers strongly posteriorly. It is tipped with a pair of small and narrow anal laminae, which are well separated and armed with short setae. The egg strings are a trifle wider than the abdomen and about as long as the carapace; each contains from seventy to eighty eggs.

Of the appendages the first antennae are large, more than half the length of the frontal plates; the two joints are the same length, the terminal one being narrow and club-shaped.

The second pair are of medium size; the basal joint is not much swollen and is furnished on its dorsal surface, at the inner corner of the distal margin, with a circular plate covered with short and stiff bristles. The terminal claw stands at right angles to the basal joint and is sharply bent near its tip.

The first maxillae are small, slender, and strongly curved; the second pair are also small and are cut beyond the center, the inner branch being considerably smaller than the outer one. The mandibles are strongly curved at the tip, with about a dozen large serrate teeth along the inner margin of the curve. The first maxillipeds have a small chitin lamina inserted in the inner margin of the terminal joint near its center. They terminate in three claws instead of the usual two; the inner one is considerably longer than the two outer ones, which are about the same length. The outer claw has a pectinate edge along its outer margin.

The second maxillipeds are small, the terminal claw not more than a third the length of the basal joint, with a long and slender accessory spine inserted near its base.

The furca is small, the base longer than the branches and somewhat swollen, with a large rectangular foramen. The branches are short, well separated, a little divergent, and blunt at the tips.

The first swimming legs have a large plumose seta on the posterior margin of the basal joint and a stout spine at its distal corner. There

is a slender spine at the anterior distal corner of the second joint and the usual armature on the terminal joint, three plumose setæ on the posterior margin, three terminal claws, and a spine at the distal corner.

The second legs are like those of *Caligus* and *Lepeophtheirus*. The rami of the third legs are very close together, but are not at all fused. They project well beyond the edge of the basal apron. The exopod is three-jointed and the endopod two-jointed. All the spines and setæ are small except those on the respective basal joints.

The fourth legs are large. The basal joint is stout, but is considerably less than half the entire length. The three terminal joints are about the same length. The second joint ends in a small and strongly curved claw; the third joint is tipped with a longer and straighter claw, while the fourth joint ends in the usual three claws, graded in size from without inwards.

At the base of each claw is a large lamina tipped with radiating bristles, like those in *Lepeophtheirus edwardsi*.

Along the outer margin of the two longest terminal claws, and along both margins of the outer shortest claw, is a wide serrated fringe or lamina, again like that in *L. edwardsi*.

The fifth legs are well defined with long setæ, but are wholly concealed in dorsal view by the dorsal lamina.

Total length 5.3 mm. Length of carapace 3.5 mm.; width of same 3.5 mm.; length of lamina covering free and genital segments 2 mm.; length of egg strings 3.1 mm. Seventy or eighty eggs in each.

Color a light cinnamon brown, the pigment uniformly distributed and not in spots.

(*palliated*, wearing a cloak or mantle.)

Male.—Carapace more quadrangular than in the female, distinctly wider than long, with the sides somewhat flattened.

Frontal plates well defined, relatively larger than in the female, the joint which separates them from the carapace almost a straight line. In this sex also the plates are completely separated by the deep median incision, in which can be seen the remains of a frontal filament. The posterior sinuses are broadly triangular, leaving a median lobe less than half the entire width. The lateral lobes are broad and well rounded and they do not curve in at all at their tips.

Grooves and thoracic areas as in the female, except that the digestive glands are very pointed anteriorly and much elongated.

The free segment is as wide as the genital segment, but is quite short. It is constricted anteriorly into a neck, where it joins the carapace, and is considerably enlarged through the bases of the fourth legs into a spindle shape.

There is no dorsal plate or lamella, as in the female, but the segment is like that in *Caligus* and *Lepeophtheirus*.

The genital segment is quadrangular in outline, slightly emarginate

posteriorly, with almost straight sides. It is only one-fourth as wide as the carapace, about as wide as long, and carries two pairs of papillæ—one on the lateral margin and the other at the posterior corners, the two close together.

The first pair, on the lateral margins, represent the fifth legs and are much better developed than in any species of *Caligus* or *Lepcophtheirus* thus far observed. On the ventral surface in favorable specimens this pair of legs may be traced to the very base of the genital segment; and they also show an indistinct segmentation, which is very unusual.

The second pair represent the sixth legs, and are in the condition usually assumed by the fifth pair, except that they show only two spines instead of three.

As in the female, the dorsal surface of this segment is covered with a lamina which projects over either lateral margin and covers the bases of the fifth legs posteriorly.

The abdomen is very short, scarcely reaching beyond the tips of the fifth-leg papillæ, and is wider than it is long, with very large anal laminae, armed with long and stout setæ.

The first antennæ are large and project well beyond the lateral margins of the carapace. The second pair are also enlarged, as usual in this sex, and well branched.

The second maxillipeds are enlarged rather more than usual, and must form powerful prehensile organs.

The basal laminae, or apron of the third legs, are very large and reach back fully to the center of the genital segment. Being plentifully supplied with powerful muscles, they form a swimming organ of great strength, and must propel the animal through the water swiftly. They must also be equally effective in the prevention of slipping.

The fourth legs are much enlarged and so long that they reach well beyond the tips of the plumose setæ on the anal laminae. The basal joint on each of them is as large as the entire free segment. They are armed, as in the female.

Total length 2.5 mm. Length of carapace 1.8 mm.; width of same 2 mm.; length of genital segment 0.35 mm.; length of the fourth legs 1.5 mm.

The National Museum collection includes a single lot of this interesting species; it is numbered W. 75, and was taken from the blue cod, *Ophiodon elongatus*, locality unknown.

Its chief interest lies in the fact that it forms a connecting link between the subfamily Caliginæ, which is here treated, and that of the Euryphorinæ, their nearest relatives.

By reference to the key on page 532 it will be seen that the Caliginæ are characterized by the entire absence of dorsal plates or appendages on the fourth segment of the thorax, with the exception of the fourth

legs. The Euryphorinæ, on the other hand, have a pair of plates on the dorsal surface of the fourth segment which usually overlap the genital segment.

The present species has a pair of dorsal plates which start at the groove between the free and genital segments and, in the female, grow backward and forward until they fuse and cover both segments. In the male they cover only the genital segment. It would seem at first as if this new genus and species should be placed with the Euryphorinæ by reason of these dorsal plates. But there are several good reasons for placing it here among the Caliginæ.

First the growth and fusion of the dorsal plates is as unlike the condition which pertains in the Euryphorinæ as it is unlike that in the Caliginæ. No genus in the former subfamily shows such a fusion of plates, nor do we find it until we come to the Pandarinæ. But in this latter subfamily the character of the appendages has changed materially, and we no longer find anything there which resembles the Caliginæ. The fusion of the plates then is like *Pandarus*, but the detail of the appendages is still like that of *Caligus Lepeophtheirus* in every particular.

Again attention has been called in both sexes to the fact that the remains of a frontal filament can still be seen in the bottom of the incision between the frontal plates.

This shows conclusively that in its development this genus has a stage during which the young are fastened by a frontal filament, exactly like the chalimus of the Caliginæ.

When we come to discuss the development of the Euryphorinæ we shall find that they possess no frontal filament but accomplish their attachment in an entirely different manner.

The present genus, therefore, in the detail of its appendages and in the different stages of its development, is very plainly one of the Caliginæ. Yet at the same time it possesses a pair of fused dorsal plates, which are developed in a manner similar to that of the Pandarinæ.

Hence it is to be classed with the Caliginæ, but regarded as exhibiting the first signs of that degeneration in structure and function so plainly shown in the Pandarinæ.

In this first beginning the dorsal plates do not stiffen the body enough, nor is their weight sufficient, to retard the copepod's freedom of motion. If they should offer an impediment in this direction the increase in the size of the apron of the third legs, which is the chief organ of locomotion, would more than offset it.

It is an extremely fortunate circumstance that this single lot of parasites includes well-preserved adults of both sexes and the young in several stages of development, so that the foregoing points are clearly demonstrated.

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EXPLANATION OF THE PLATES.

- Plate V. *Caligus rufimaculatus*, new species. Fig. 51, Dorsal view of female; fig. 52, Dorsal view of male; fig. 53, Dorsal view of a fully developed male chalinus; fig. 54, First maxilla and second antenna of female; fig. 55, First maxilliped of female; fig. 56, Second maxilla of female; fig. 57, Second maxilliped of male; fig. 58, Second maxilliped of female; fig. 59, Furca and first maxilla of male; fig. 60, Furca of female; figs. 61-64, First, second, third, and fourth swimming legs of female.
- Plate VI. *Caligus schistonyx*, new species. Fig. 65, Dorsal view of male; fig. 66, Dorsal view of female; fig. 67, Second antenna of female; fig. 68, First maxilliped of female; fig. 69, First maxilla of male and female; fig. 70, Second maxilliped of female; fig. 71, Second antenna of male; fig. 72, Second maxilla of female; fig. 73, Furca of female; fig. 74, First swimming leg of female; fig. 75, Tip of same enlarged to show the divided claws; figs. 76-78, Second, third, and fourth swimming legs of female.
- Plate VII. *Caligus rapax* Milne-Edwards. Fig. 79, Dorsal view of adult female; fig. 80, Dorsal view of adult male; fig. 81, Dorsal view of young female, showing fifth legs at the posterior corners of the genital segment; fig. 82, Second antenna of female; fig. 83, Second maxilla; fig. 84, Furca; figs. 85-88, First, second, third, and fourth swimming legs of female; fig. 89, Ventral surface of genital segment, showing the cement glands.
- Plate VIII. *Caligus mutabilis*, new species. Fig. 90, Dorsal view of female; fig. 91, Dorsal view of male; fig. 92, Second antenna; figs. 93 and 94, First and second maxillæ; fig. 95, Furca; figs. 96 and 97, First and second

maxillipeds; figs. 98, 100–102, First, second, third, and fourth swimming legs; fig. 99, One of the plumose setae from the posterior border of the terminal joint of the first legs. All the appendages are from the female.

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Plate X. *Caligus curtus* Müller. Fig. 112, Dorsal view of male; fig. 113, Dorsal view of female; fig. 114, Very young Chalimus, the third thorax segment not fully fused with the head; fig. 115, Fully developed male Chalimus; fig. 116, First maxilliped; fig. 117, Second maxilliped; fig. 118, Furca; fig. 119, Second swimming leg; fig. 120, First swimming leg; figs. 121, 122, Third and fourth swimming legs; fig. 123, Second antenna of male; fig. 124, Second maxilliped of male.

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Plate XIII. *Caligus bonito*, new species, and *Caligus pelamydis* Kröyer. Fig. 150, *Caligus bonito*, dorsal view of female with egg strings; fig. 151, dorsal view of female without egg strings, drawn by Richard Rathbun; fig. 152, Dorsal view of male, drawn by Richard Rathbun; fig. 153, Posterior part of young female, showing the abdomen segments of about equal length; fig. 154, *Caligus pelamydis*, dorsal view of female; fig. 155, Second antenna; fig. 156, First and second maxillae; fig. 157, Second maxilliped; fig. 158, Furca; figs. 159–161, Second, third, and fourth swimming legs.

Plate XIV. *Caligus productus* Dana and *Caligus isonyx* Steenstrup and Lütken. Fig. 161 a, First swimming leg of *Caligus pelamydis*; fig. 162, *Caligus productus*, dorsal view of female; fig. 163, Second antenna; fig. 164, Second maxilla; fig. 165, Furca; fig. 166, Second maxilliped; figs. 167–170, First, second, third, and fourth swimming legs; fig. 171, *Caligus isonyx*, dorsal view of female, after Steenstrup and Lütken.

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fig. 182, Furca; fig. 183, First swimming leg, showing absence of plumose setæ on the terminal joint; fig. 184, *C. isonyx*, second maxilla; fig. 185, Furca; fig. 186, Fourth swimming leg. The figures on this plate are all taken from the respective authors named.

Plate XVI. *Caligodes megalcephalus*, new species. Fig. 187, Dorsal view of female; fig. 188, Second antenna; fig. 189, Second maxilla; fig. 190, Accessory spine on either side of the mouth tube; fig. 191, Furca; fig. 192, Second maxilliped; figs. 193–195, First, second, and fourth swimming legs.

Plate XVII. *Echetus typicus* Kröyer. Fig. 196, Dorsal view of female; fig. 197, Side view of same female; fig. 198, Second antenna; fig. 199, Mouth tube and second maxilla; fig. 200, First maxilliped; fig. 201, Second maxilliped; figs. 202–205, First, second, third, and fourth swimming legs.

Plate XVIII. *Lepeophtheirus*. Fig. 206, *Lepeophtheirus longipes*, new species, dorsal view of female; fig. 207, Second antenna; fig. 208, Second maxilliped; fig. 209, Furca; figs. 210, 211, First and second swimming legs; fig. 212, *L. thompsoni* Baird, dorsal view of female; fig. 213, Second antenna; fig. 214, Furca; fig. 215, Second maxilla; fig. 216, Second maxilliped; figs. 217–219, First, second, and fourth swimming legs. Fig. 220, *L. innominatus*, new species, second maxilla; fig. 221, Furca. These two figures are under the same magnification as figs. 214 and 215. Fig. 222, *L. longipes*, second maxilla.

Plate XIX. *Lepeophtheirus nordmanni* Milne-Edwards. Fig. 223, Dorsal view of female, drawn by Emerton; fig. 224, Dorsal view of male; fig. 225, Second antenna; fig. 226, First maxilla; fig. 227, Second maxilla; fig. 228, Second maxilliped; fig. 229, Furca; figs. 230–233, First, second, third, and fourth swimming legs.

Plate XX. *Lepeophtheirus hippoglossi* Kröyer. Fig. 234, Dorsal view of female; fig. 235, Dorsal view of male; fig. 236, Second antenna; fig. 237, Second maxilla; fig. 238, Second maxilliped; fig. 239, Furca; figs. 240–243, First, second, third, and fourth swimming legs.

Plate XXI. *Lepeophtheirus edwardsi*, new species. Fig. 244, Dorsal view of female; fig. 245, Dorsal view of male; fig. 246, Second antenna of female; fig. 247, Terminal claw of second antenna of male; fig. 248, Second maxilla of female; fig. 249, Second maxilla of male with accessory chitin ridge; fig. 250, Furca; fig. 251, Second maxilliped of female; figs. 252–255, First, second, third, and fourth swimming legs; fig. 256, Ventral view of genital segment of female, showing *c. g.* cement gland; *o.* oviduct; *s.* spermatophores; *s. r.* semen receptacles; *va.* vagina; fig. 257, Newly hatched nauplius, the pigment spots a deep yellowish purple.

Plate XXII. *Lepeophtheirus*. Fig. 258, *L. edwardsi*, dorsal view of chalimus, half developed; fig. 259, *L. dissimulatus*, new species, dorsal view of male; fig. 260, Dorsal view of female; fig. 261, Second antenna of female; fig. 262, Second antenna of male, showing branches; fig. 263, First maxilla; fig. 264, Second maxilla of Galapagos specimen; fig. 265, The same, Bermuda specimen; fig. 266, Furca of Galapagos specimen; fig. 267, The same, Bermuda specimen; fig. 268, Second maxilliped; figs. 269–272, First, second, third, and fourth swimming legs; fig. 273, Ventral view of genital segment and abdomen of Bermuda specimen; fig. 274, The same, Galapagos specimen.

Plate XXIII. *Lepeophtheirus parviventris*, new species, and *L. bifurcatus*, new species. Fig. 275, *L. parviventris*, dorsal view of female; fig. 276, Dorsal view of male; fig. 277, Second antenna, with accessory spine; fig. 278,

Second maxilla; fig. 279, Furca; fig. 280, Second maxilliped; figs. 281-284, First, second, third, and fourth swimming legs; fig. 285, *L. bifurcatus*, dorsal view of female; fig. 286, Second antenna with accessory spine; fig. 287, First maxilla; fig. 288, Second maxilla; fig. 289, Second maxilliped; fig. 290, Furca; figs. 291-293, First, second, and fourth swimming legs, with one of the toothed and ribbed plates at the base of the spines on the fourth legs.

Plate XXIV. *Lepeophtheirus salmonis* Kröyer. Fig. 294, Dorsal view of female; fig. 295, Dorsal view of male; fig. 296, Second antenna; fig. 297, First maxilla; fig. 298, Furca; fig. 299, Second maxilliped; fig. 300, First maxilliped; figs. 301-303, First, second, and fourth swimming legs.

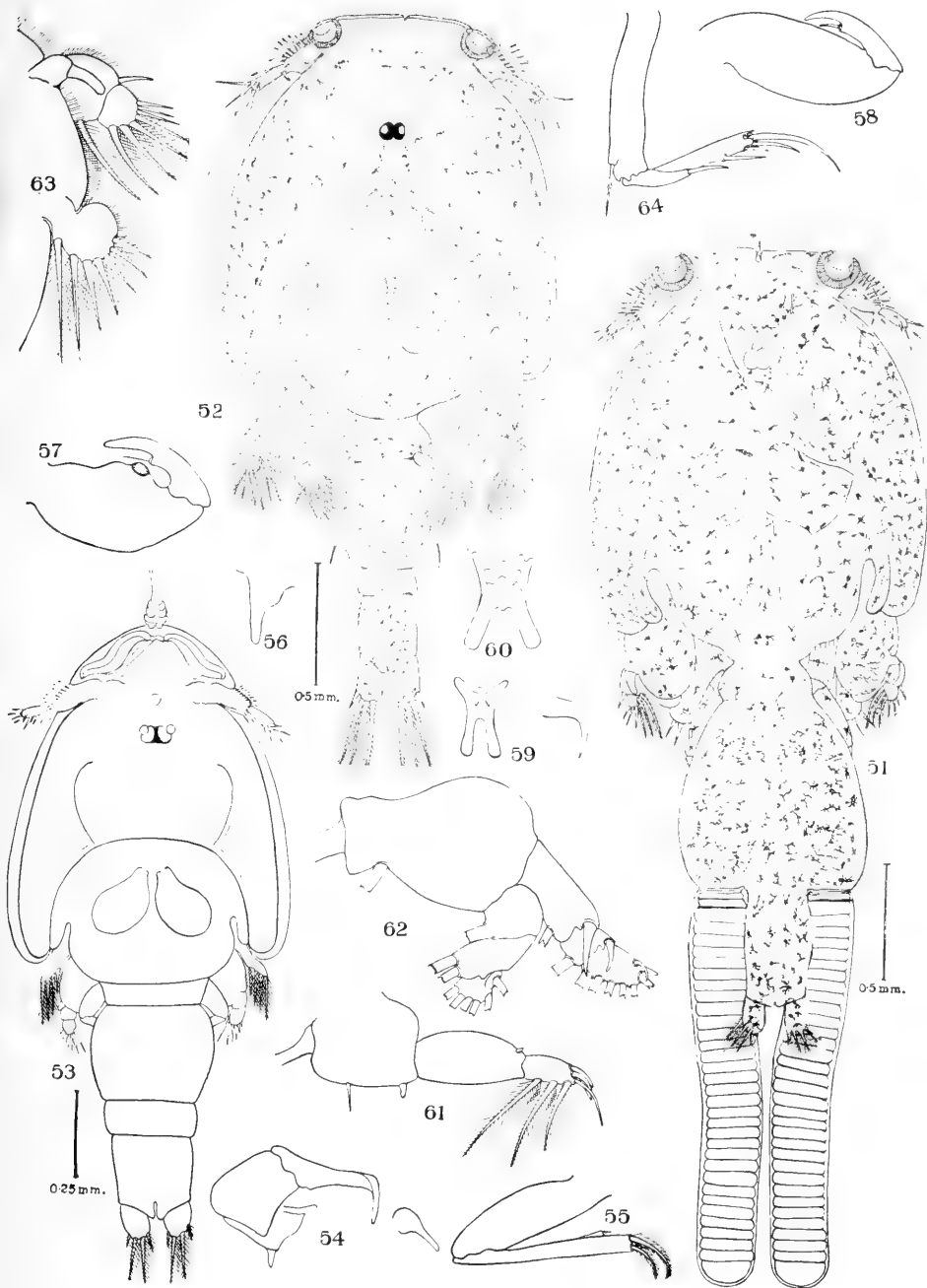
Plate XXV. *Lepeophtheirus* and *Anuretes*. Fig. 304, *L. pacificus* Gissler, dorsal view of female; fig. 305, Abdomen of the same after treatment with acetic acid; fig. 306, Second antenna; fig. 307, Second maxilla; fig. 308, Second maxilliped; fig. 309, Mandible; fig. 310, Fourth swimming leg. All the figures after Gissler. Fig. 311, *L. cossyphi* Kröyer, genital segment and abdomen of female; fig. 312, Fourth swimming leg; fig. 313, Third swimming leg. All the figures from Kröyer, and the only ones ever published. Fig. 314, *L. robustus* Kröyer, first swimming leg of male; fig. 315, Furca. Both figures from Kröyer, and the only ones ever published. Fig. 316, *Anuretes heckelii* Kröyer, ventral view of female; fig. 317, Second antenna; fig. 318, Second maxilla; fig. 319, Second maxilliped; fig. 320, Furca; fig. 321, Fourth swimming leg. All the figures from Kröyer.

Plate XXVI. *Caligus teres*, new species. Fig. 322, Dorsal view of female; fig. 323, Dorsal view of male; fig. 324, Second antenna and first maxilla; fig. 325, Second maxilla; figs. 326, 327, First and second maxillipeds; fig. 328, Furca; figs. 329-332, First, second, third, and fourth swimming legs.

Plate XXVII. *Caligus centrodonti* Baird. Fig. 333, Dorsal view of female; fig. 334, Dorsal view of male; fig. 335, Second antenna; fig. 336, First maxilla; fig. 337, Second maxilla and mouth tube; fig. 338, Furca; fig. 339, Second maxilliped; figs. 340-343, First, second, third, and fourth swimming legs; fig. 344, Genital segment and abdomen of male, ventral view.

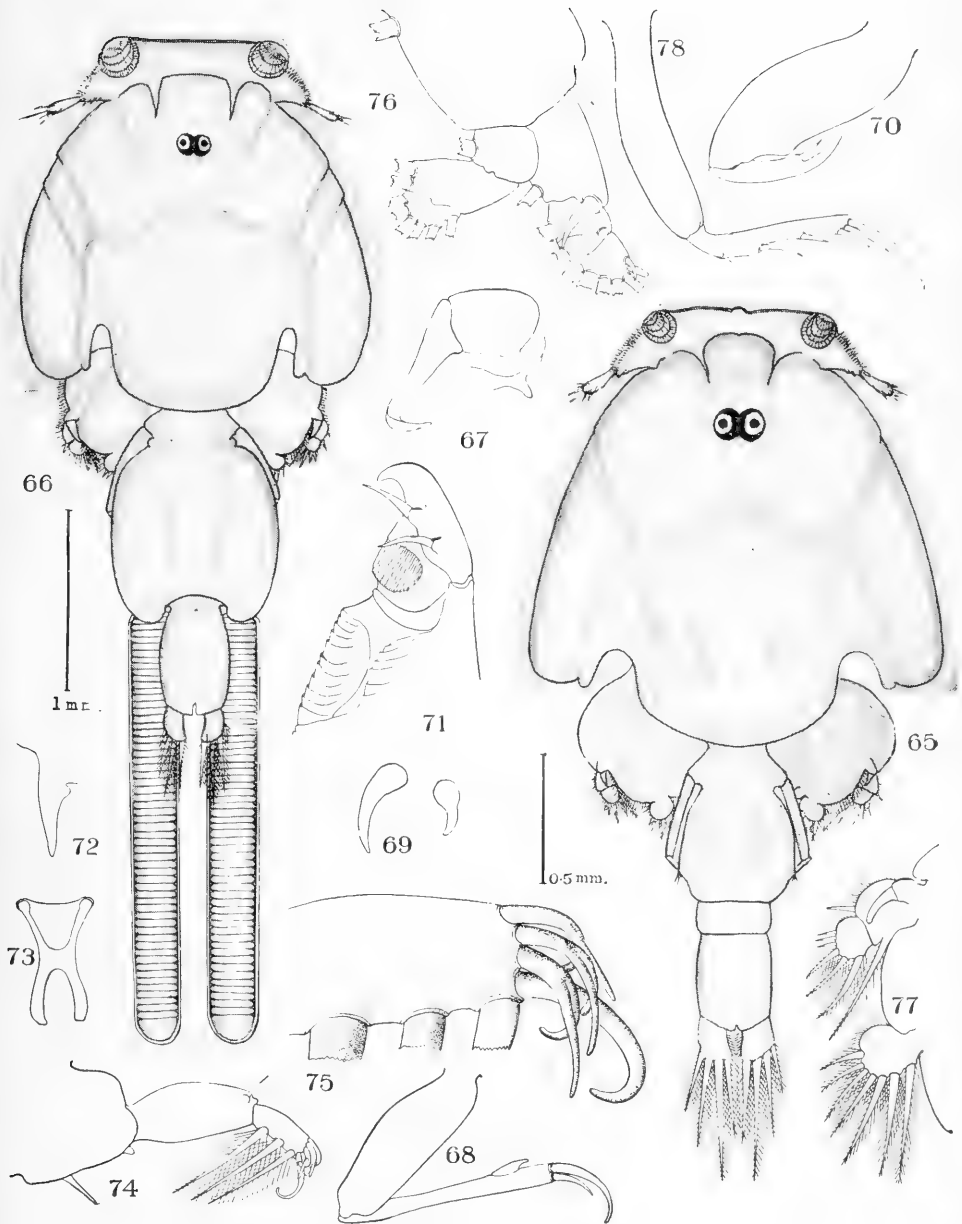
Plate XXVIII. *Lepeophtheirus innominatus*, new species, and *L. chilensis*, new species. Fig. 345, *L. innominatus*, dorsal view of female; fig. 346, Second maxilla; fig. 347, Second antenna; fig. 348, Second maxilliped; figs. 349-352, First, second, third, and fourth swimming legs; fig. 353, *L. chilensis*, dorsal view of female; fig. 354, Dorsal view of male; fig. 355, Second antenna; fig. 356, First maxilla; fig. 357, Second maxilla; fig. 358, Furca; fig. 359, Second maxilliped; figs. 360-363, First, second, third, and fourth swimming legs; fig. 364, Dorsal view of genital segment and abdomen of a young female, showing fifth legs.

Plate XXIX. *Homoioles palliata*, new genus and new species. Fig. 365, Dorsal view of female; fig. 366, Dorsal view of male; fig. 367, Second antenna; fig. 369, Mandible; figs. 370, 371, First and second maxillipeds; fig. 372, Furca; figs. 373-376, First, second, third, and fourth swimming legs; fig. 377, Dorsal view of genital segment and abdomen of male, showing dorsal plate grown down over the fifth and sixth legs; fig. 378, Dorsal view of genital segment of young female, showing that the dorsal plate is really made up of two plates which start on either side at the base of the segment and afterwards fuse along the mid-line; fig. 379, Ventral view of genital segment of male, showing the fifth and sixth legs.



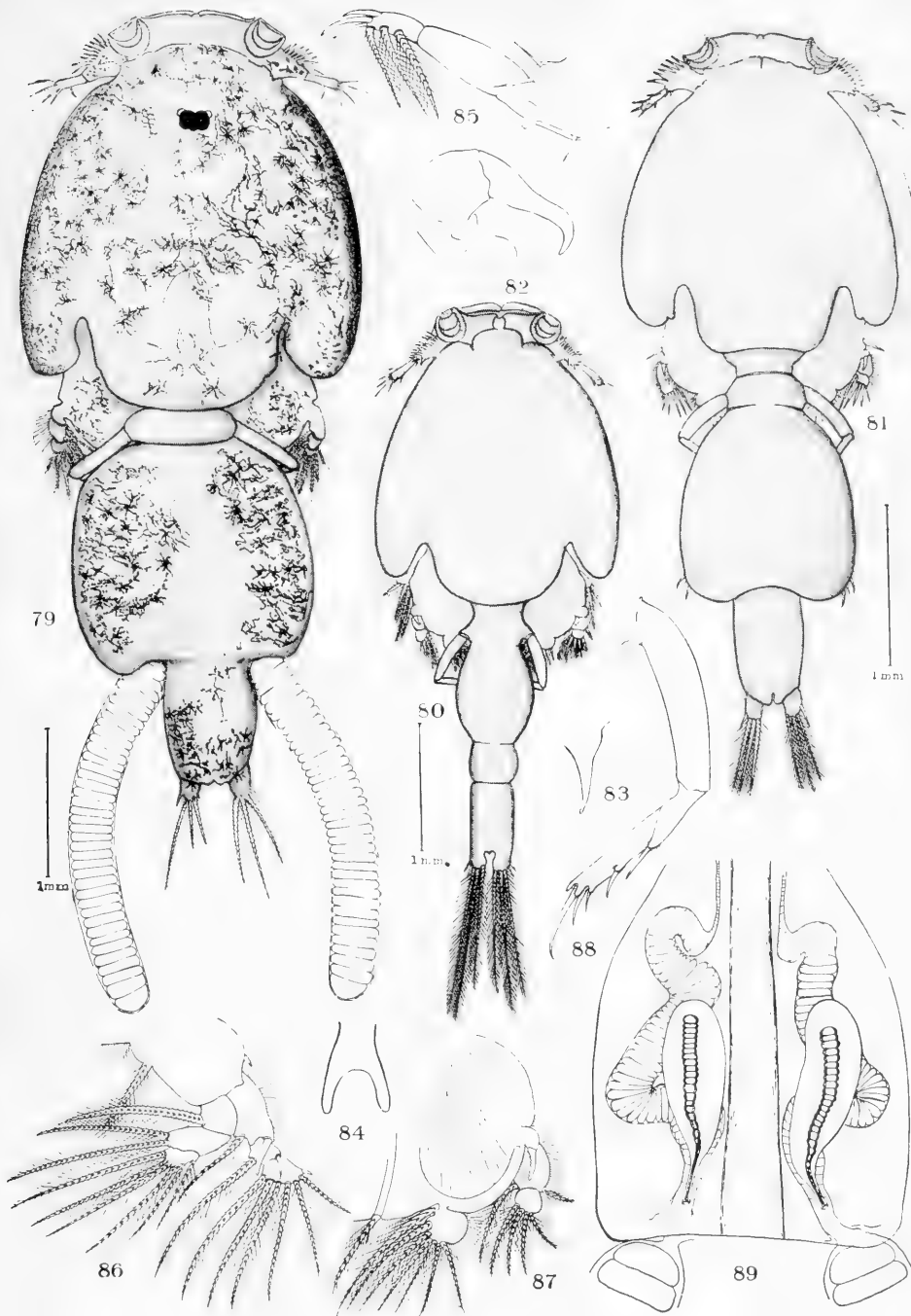
THE MALE AND FEMALE OF *CALIGUS RUFIMACULATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 669.



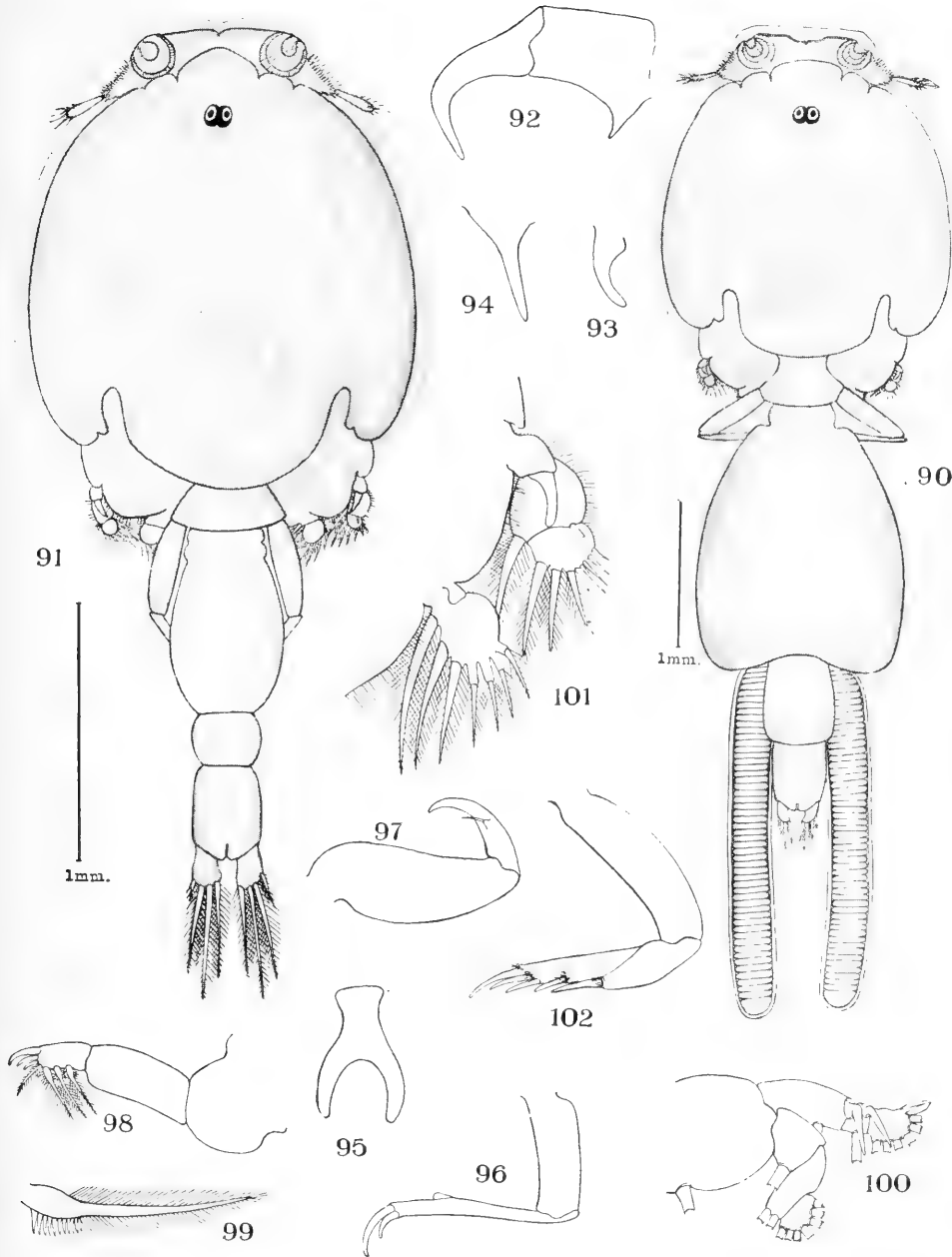
THE MALE AND FEMALE OF *CALIGUS SCHISTONYX*.

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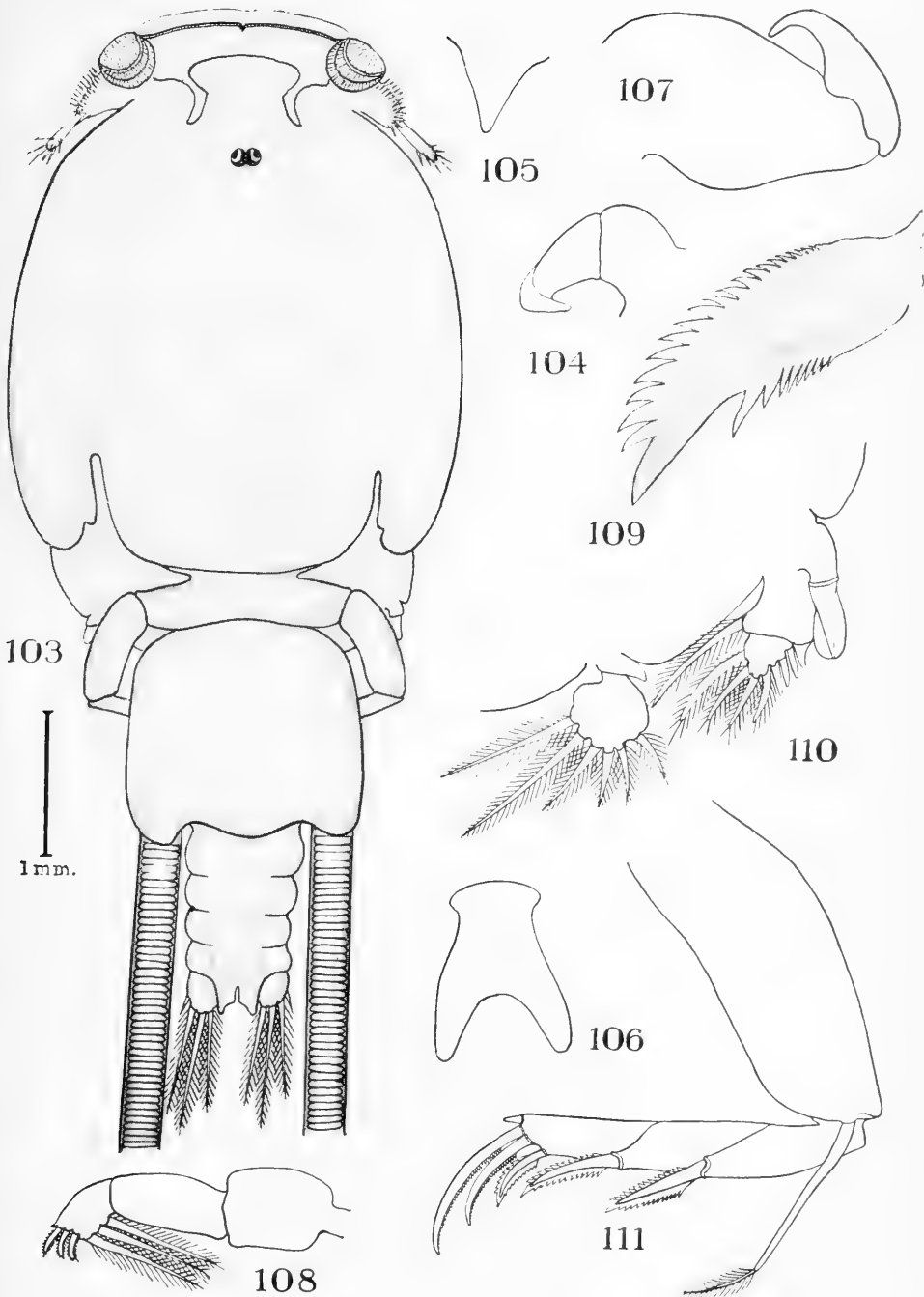
THE MALE AND FEMALE OF CALIGUS RAPAX.

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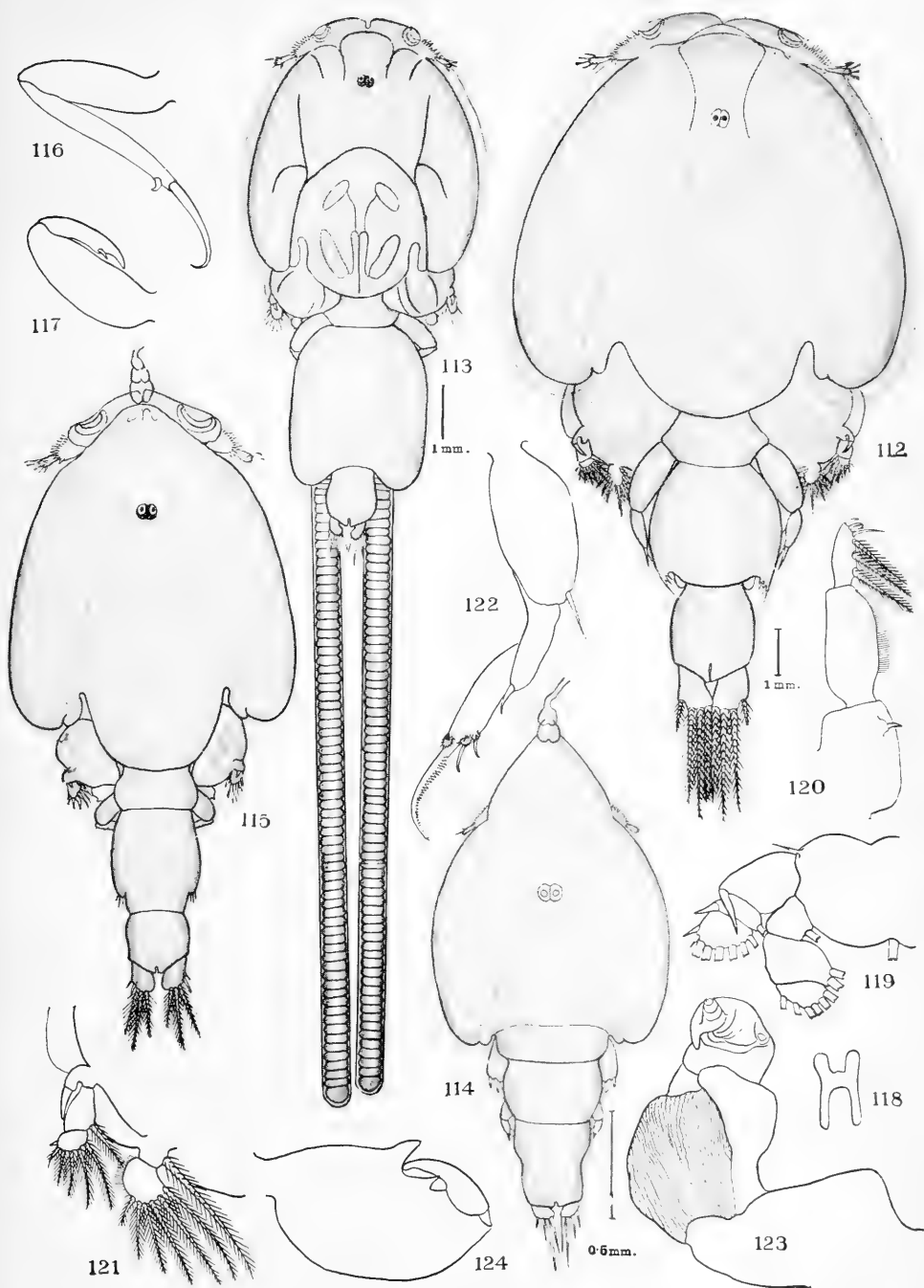
THE MALE AND FEMALE OF *CALIGUS MUTABILIS*.

FOR EXPLANATION OF PLATE SEE PAGES 669, 670.



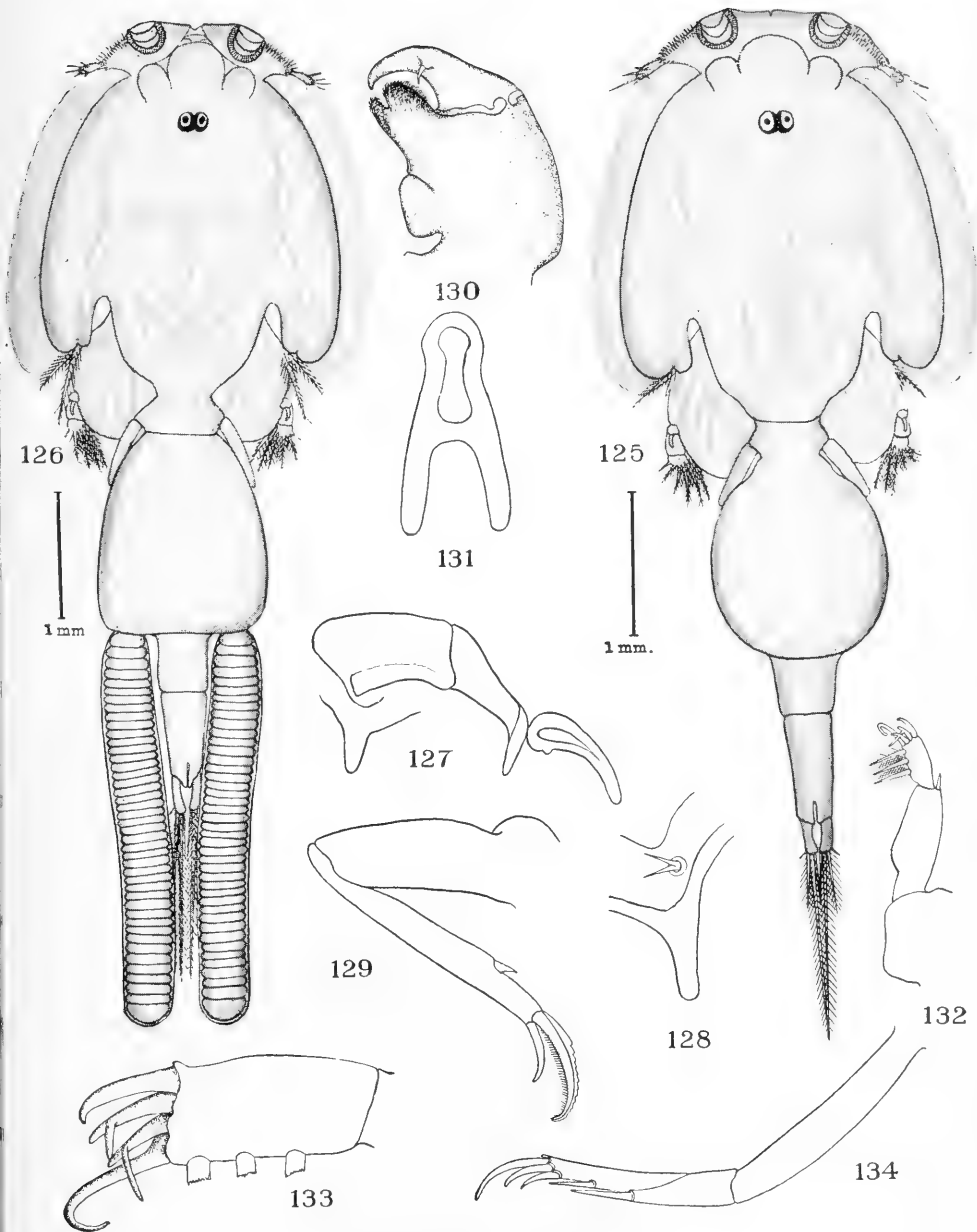
THE FEMALE OF CALIGUS ALIUNCUS.

FOR EXPLANATION OF PLATE SEE PAGE 670.



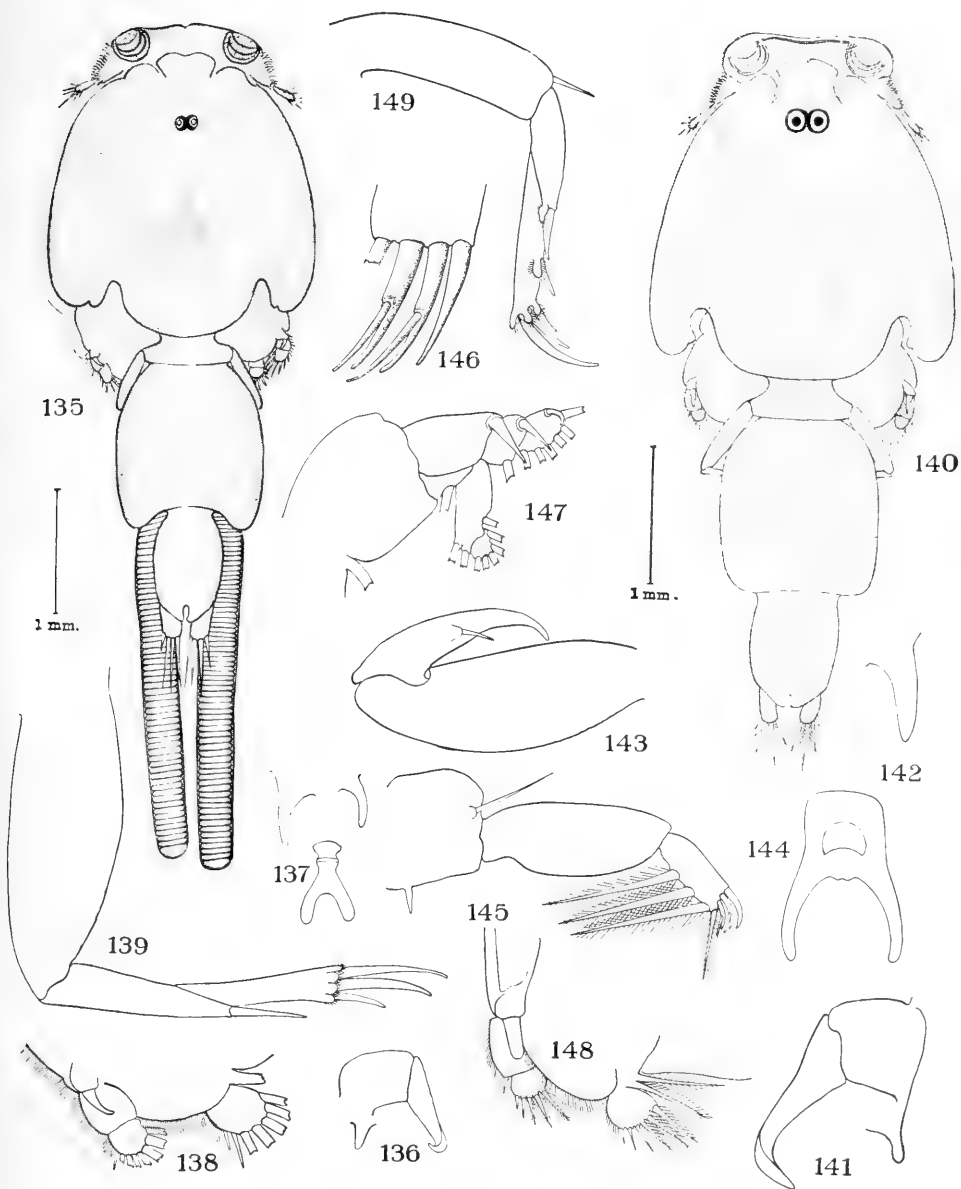
THE MALE, FEMALE, AND CHALIMUS OF *CALIGUS CURTUS*.

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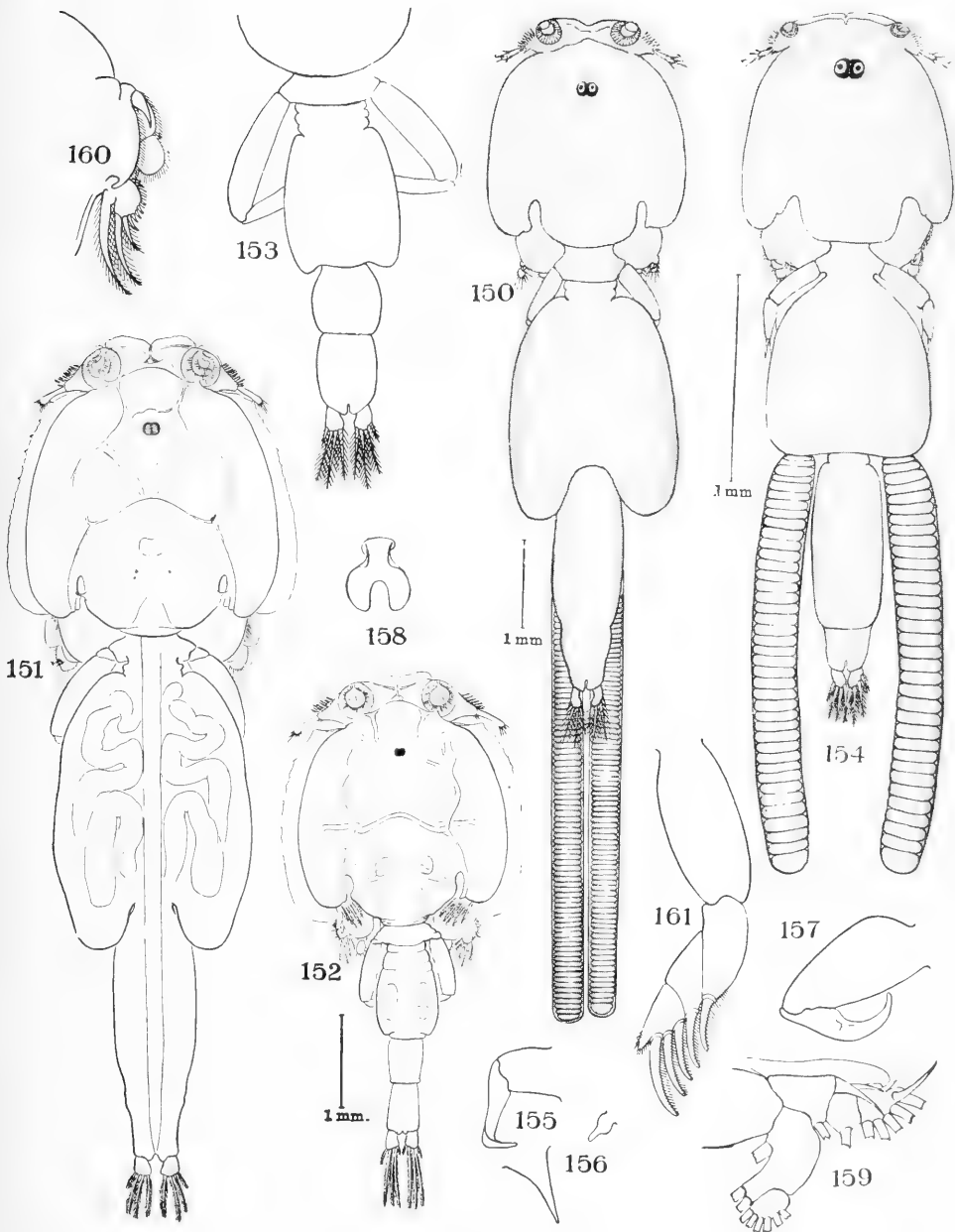
THE FEMALE OF CALIGUS CHELIFERA.

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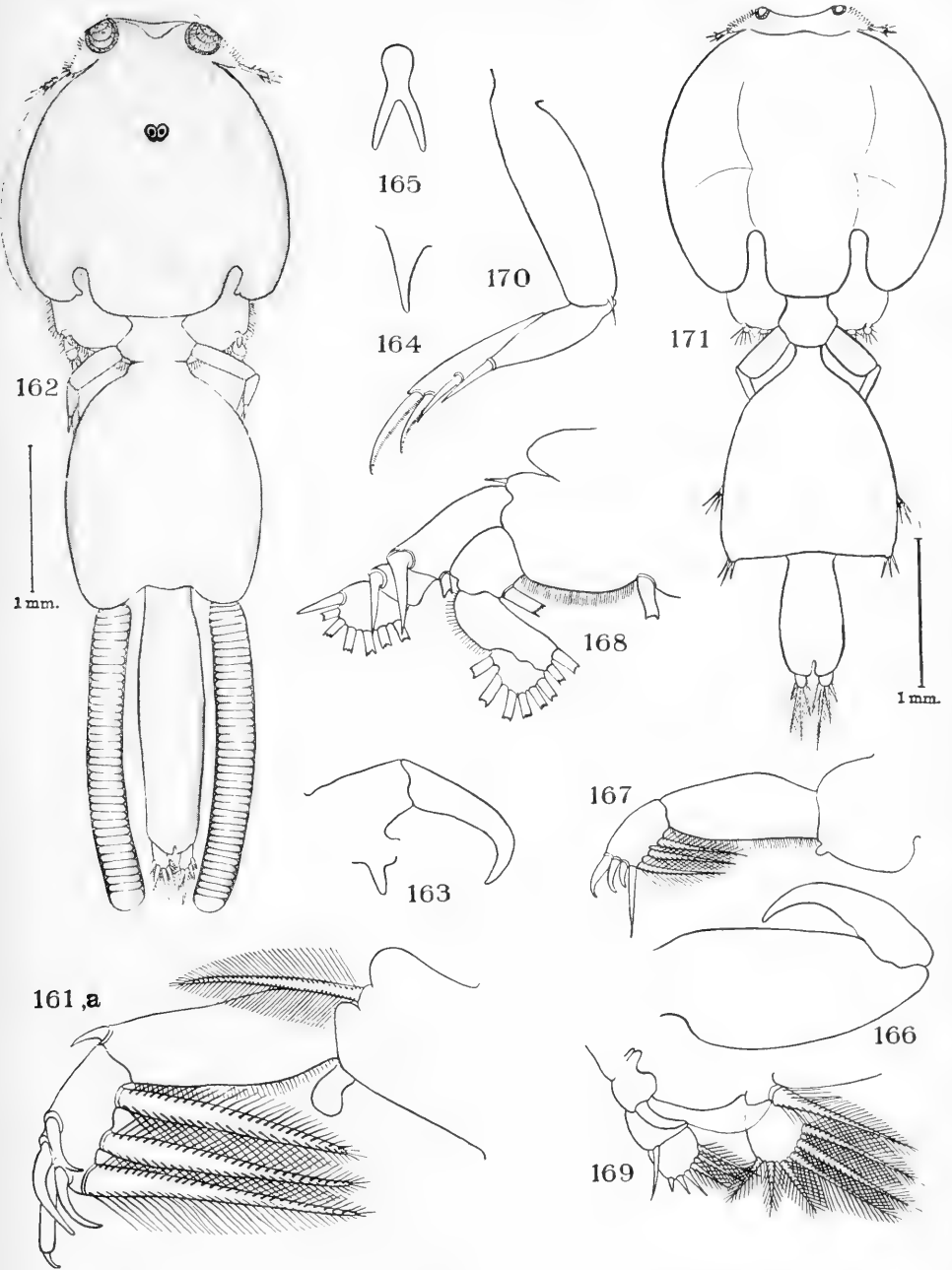
THE FEMALES OF *CALIGUS BELONES* AND *CALIGUS LATIFRONS*.

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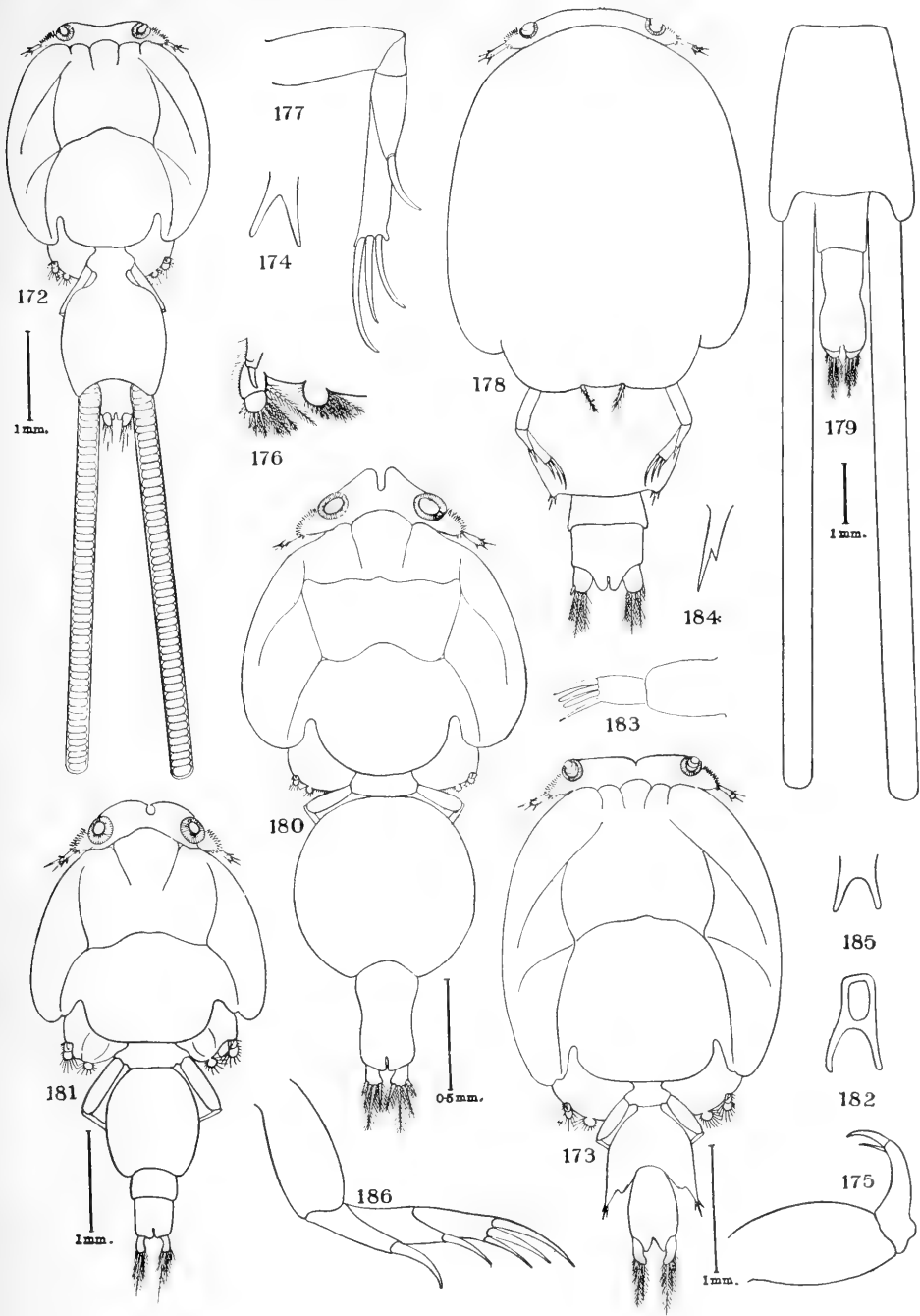
CALIGUS BONITO AND CALIGUS PELAMYDIS.

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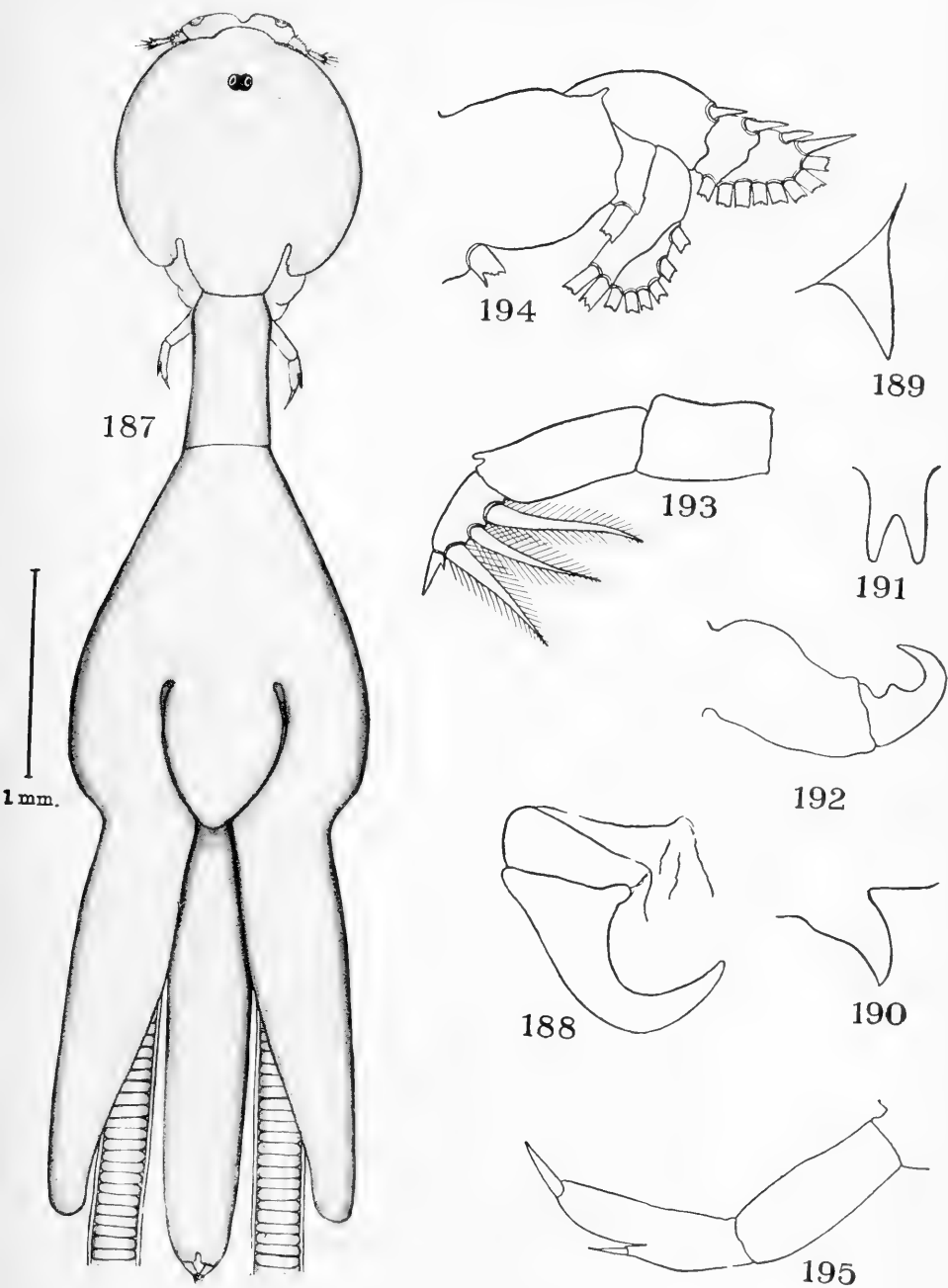
CALIGUS PRODUCTUS AND CALIGUS ISONYX.

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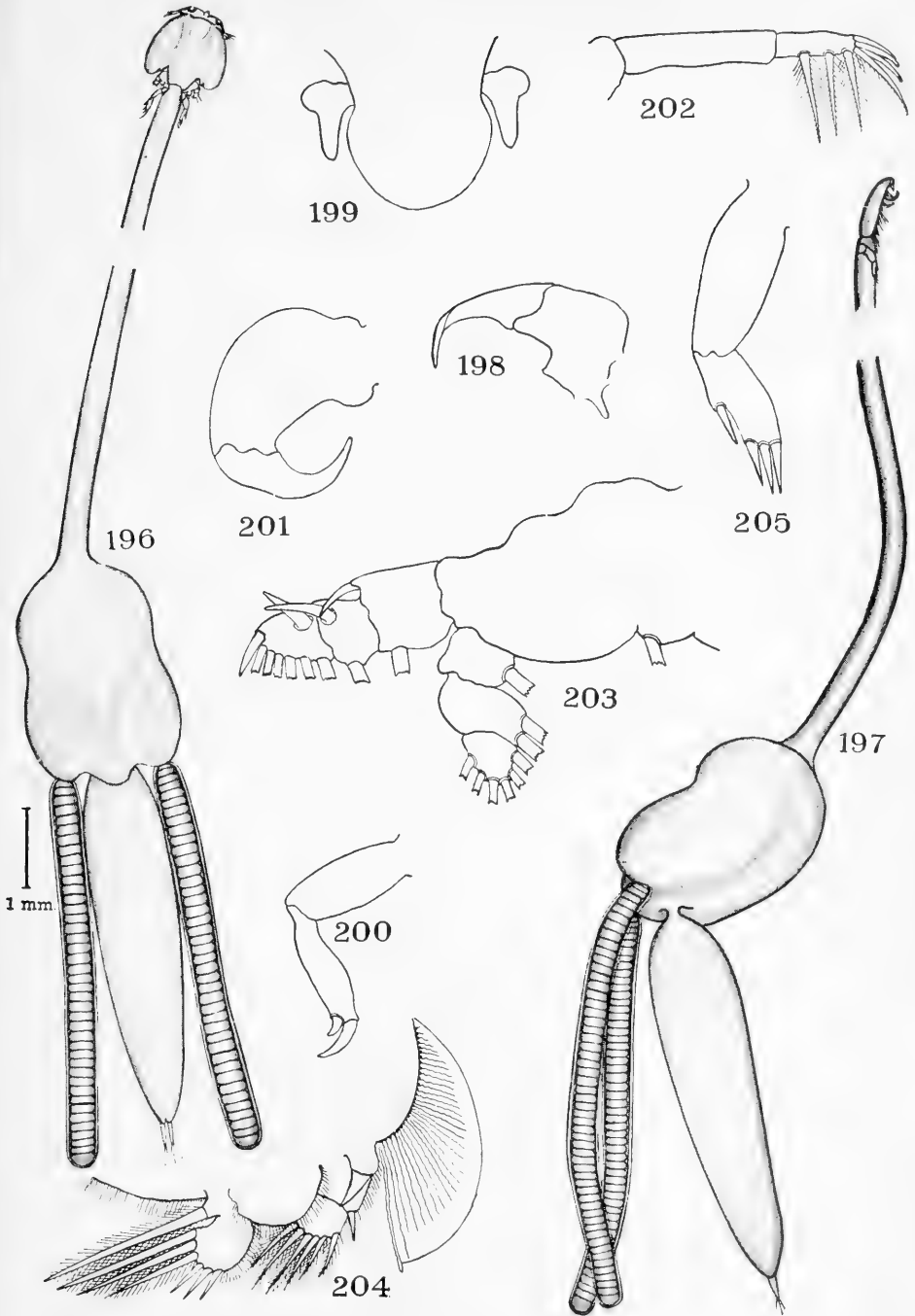
CALIGUS SPECIES FROM THE WEST INDIES.

FOR EXPLANATION OF PLATE SEE PAGES 670, 671.



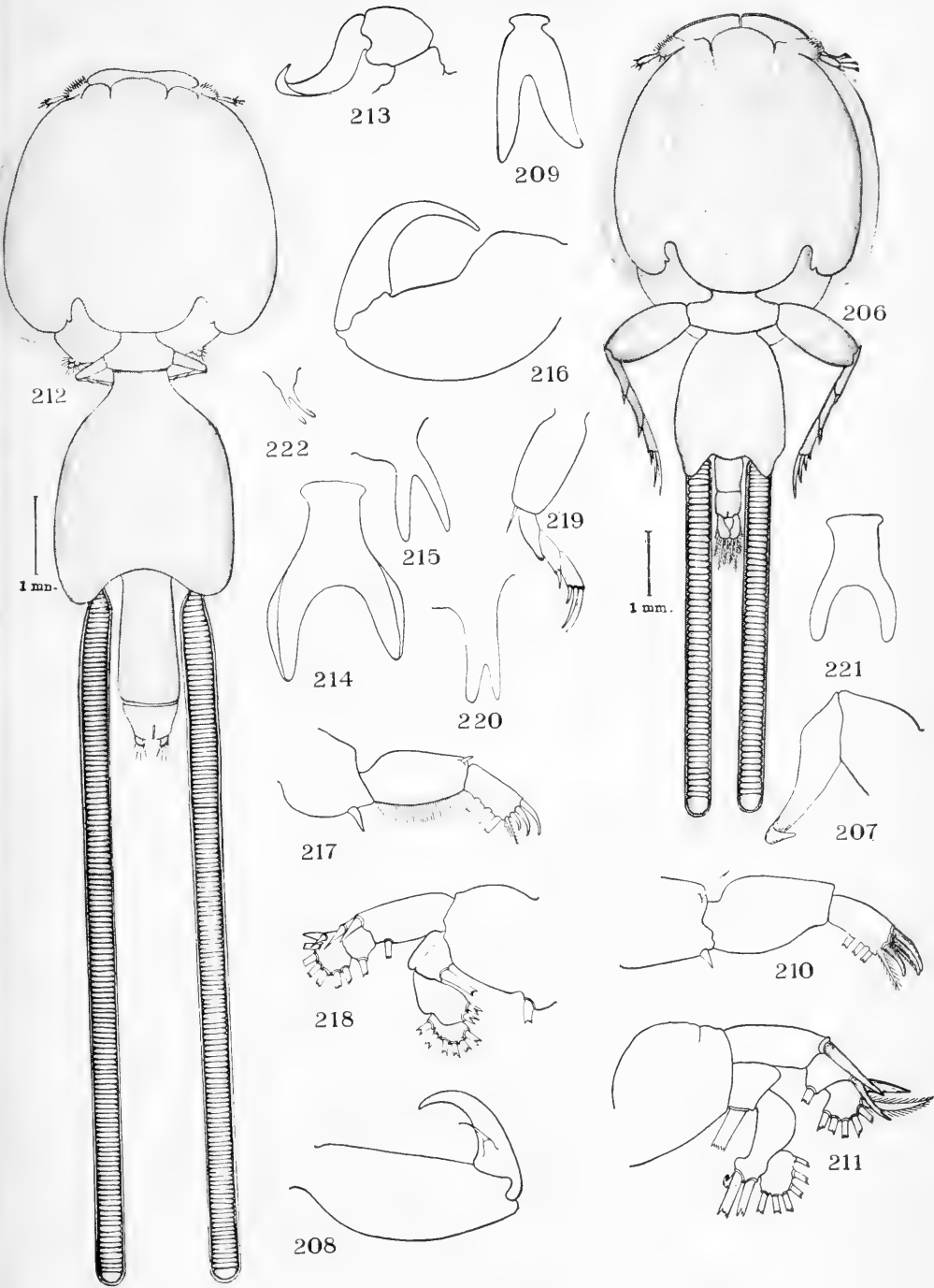
THE FEMALE OF CALIGODES MEGACEPHALUS.

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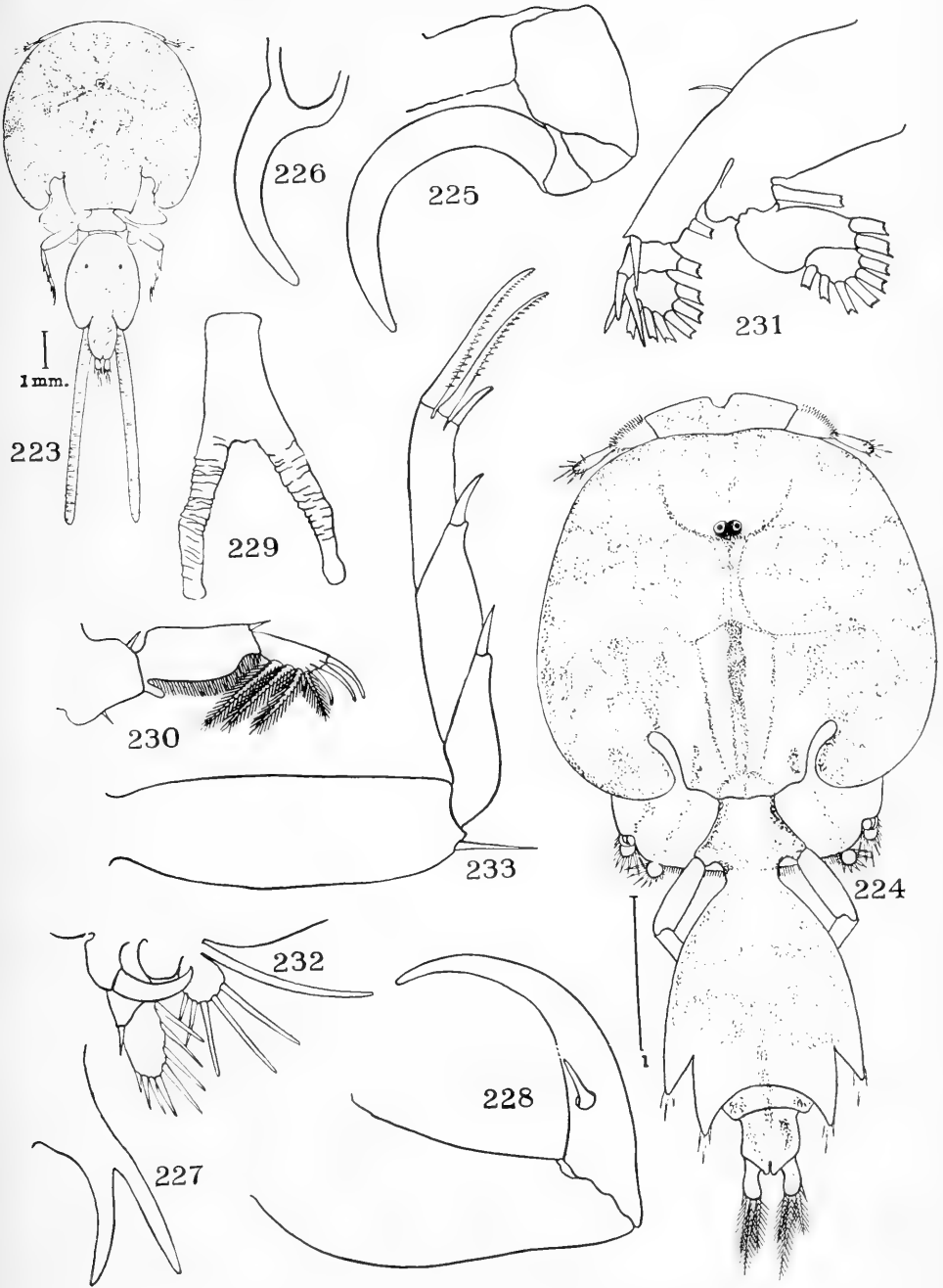
THE FEMALE OF *ECHETUS* TYPICUS.

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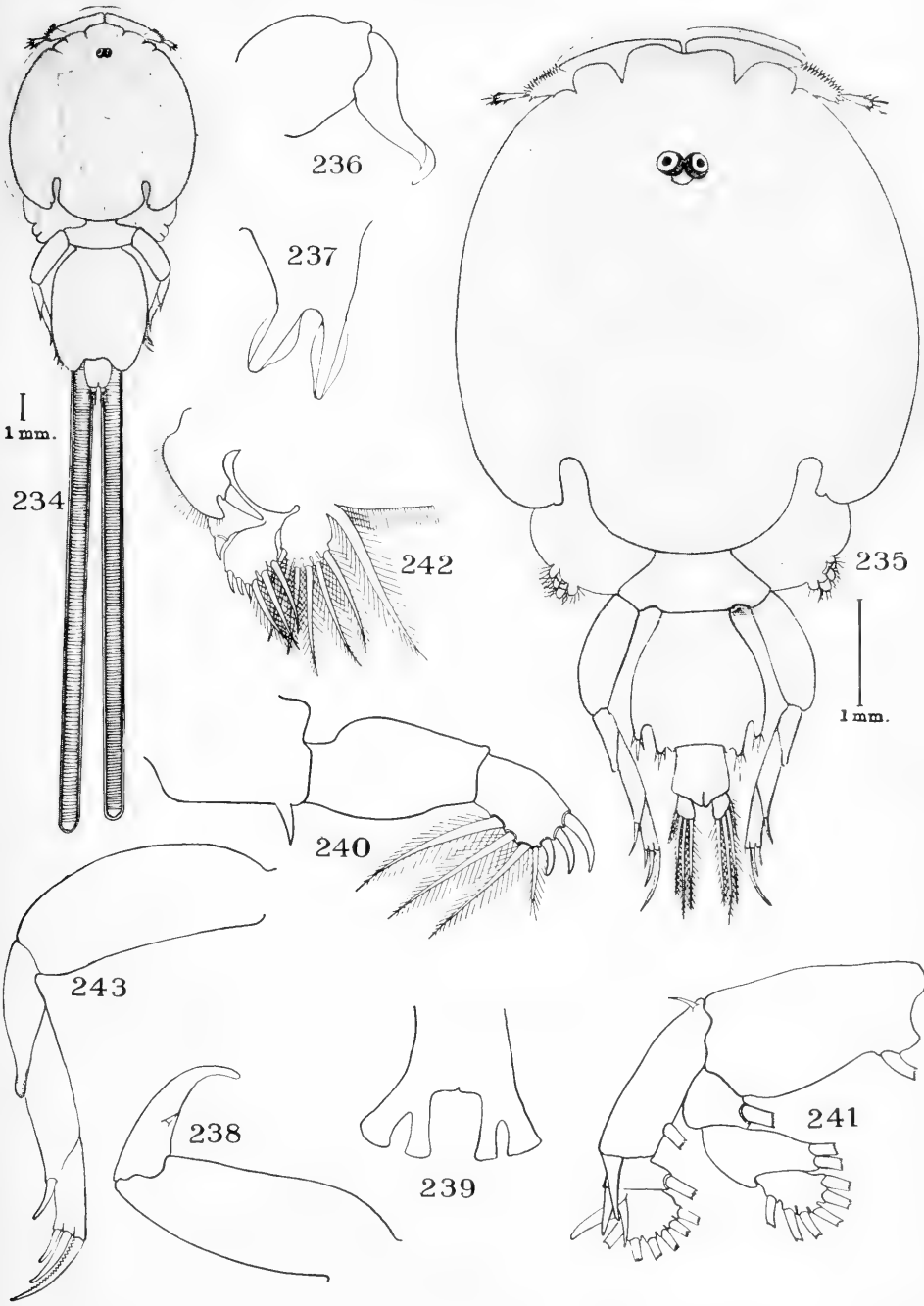
LEPEOPHTHEIRUS LONGIPES AND LEPEOPHTHEIRUS THOMPSONI.

FOR EXPLANATION OF PLATE SEE PAGE 671.



THE MALE AND FEMALE OF *LEPEOPHTHEIRUS NORDMANNII*.

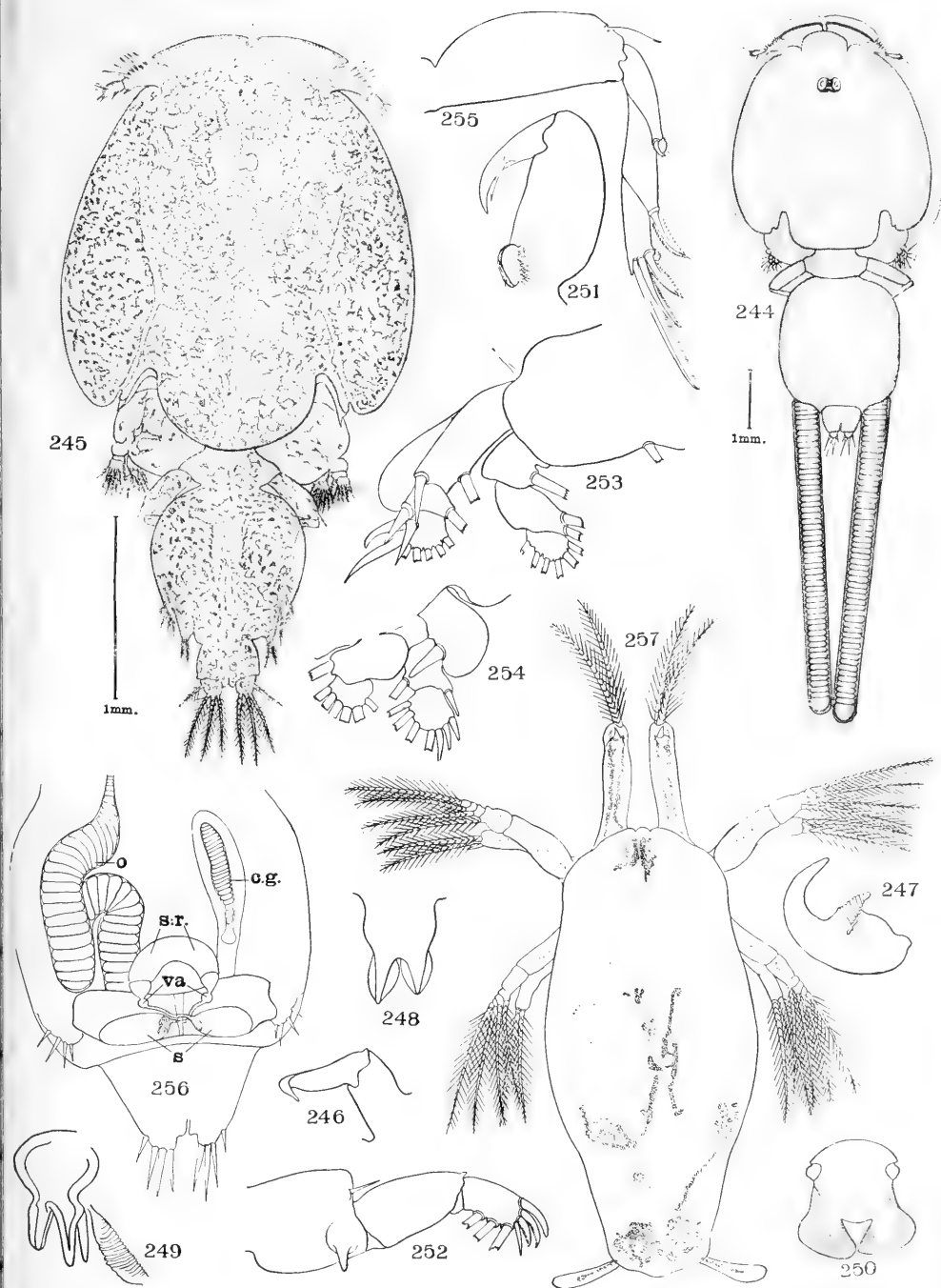
FOR EXPLANATION OF PLATE SEE PAGE 671.



THE MALE AND FEMALE OF *LEPEOPHTHEIRUS HIPPOGLOSSI*.

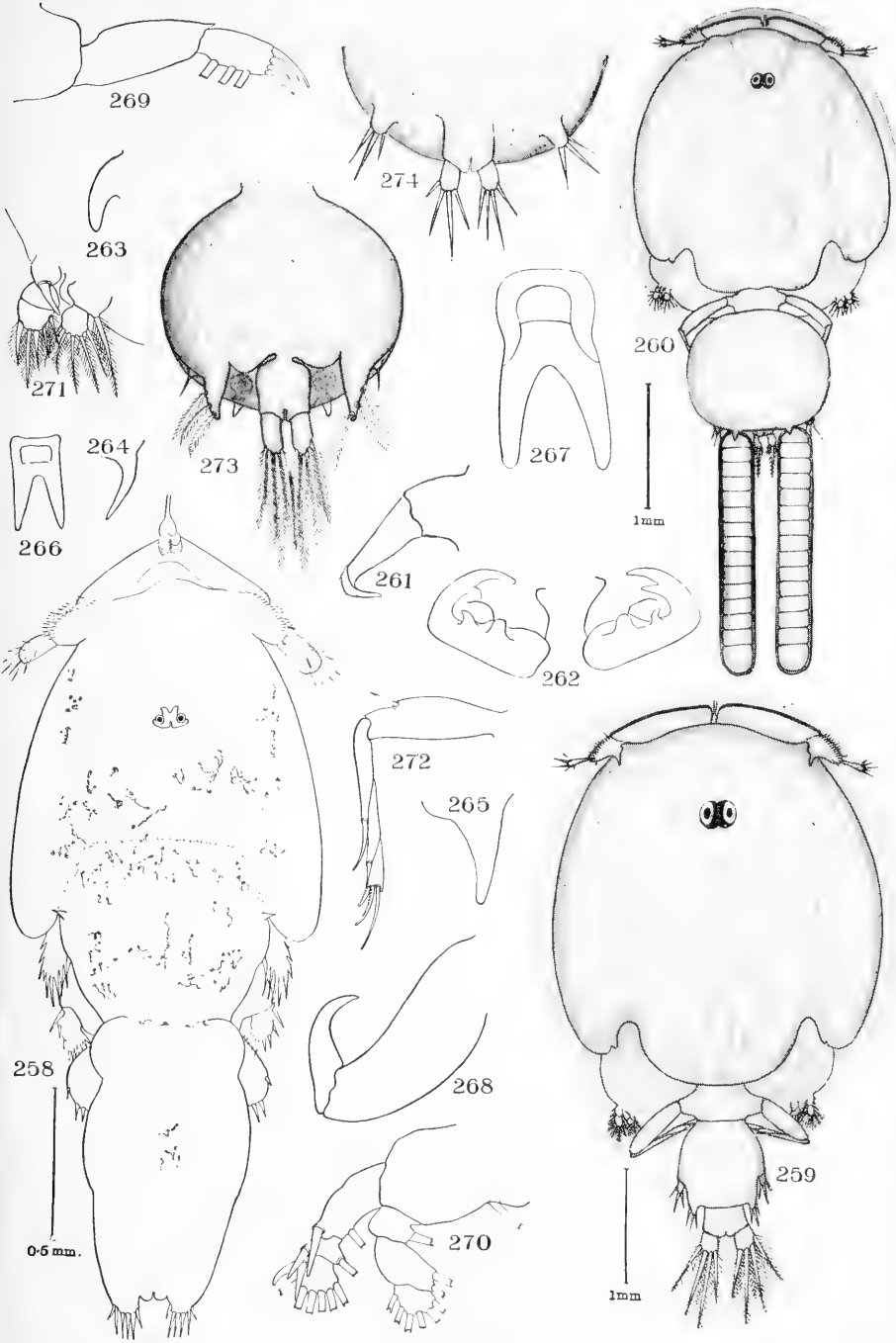
FOR EXPLANATION OF PLATE SEE PAGE 671.



THE MALE, FEMALE, AND NAUPLIUS OF *LEPEOPHTHEIRUS EDWARDSI*.

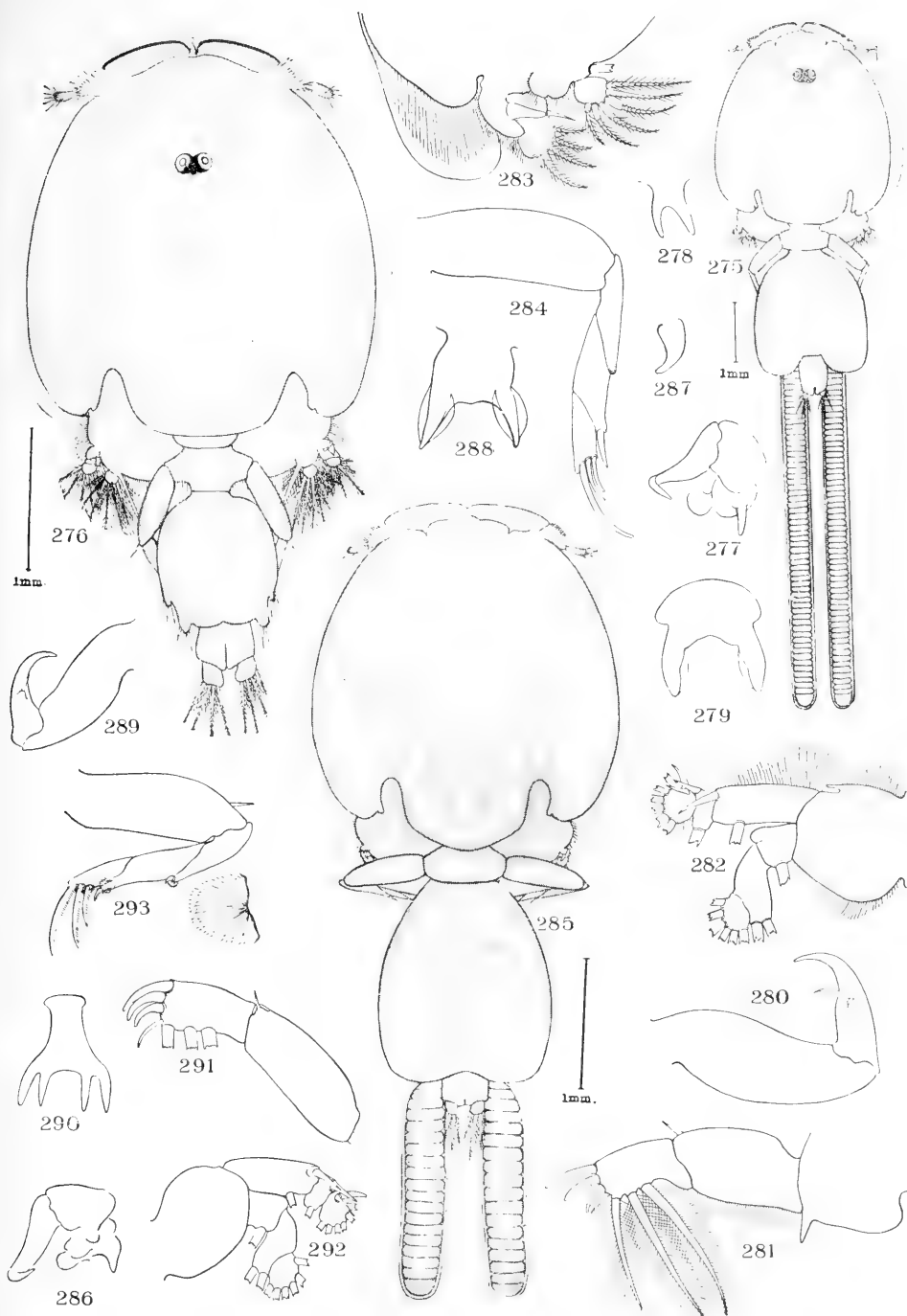
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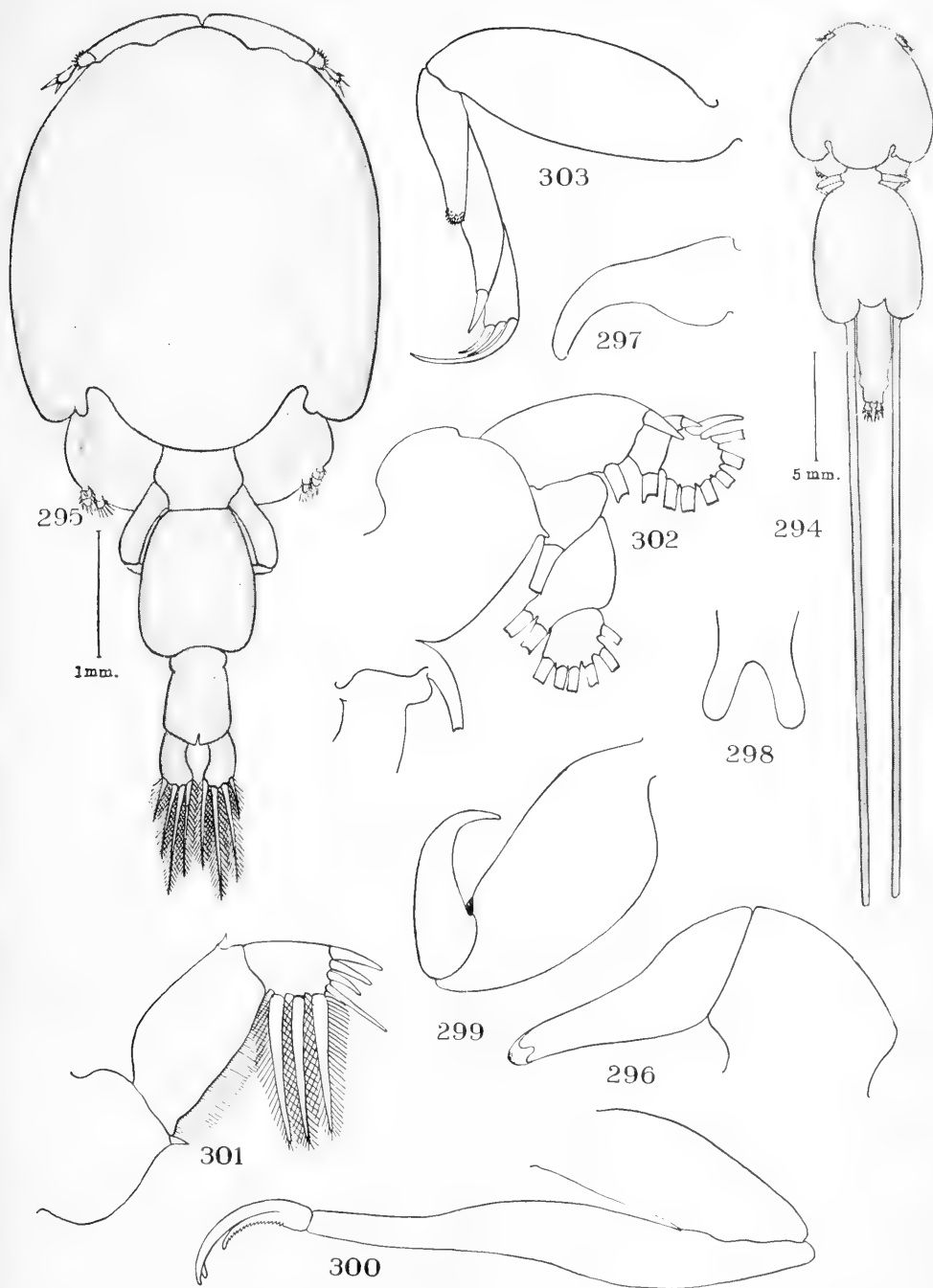
THE MALE AND FEMALE OF *LEPEOPHTHEIRUS DISSIMULATUS*.

FOR EXPLANATION OF PLATE SEE PAGE 671.



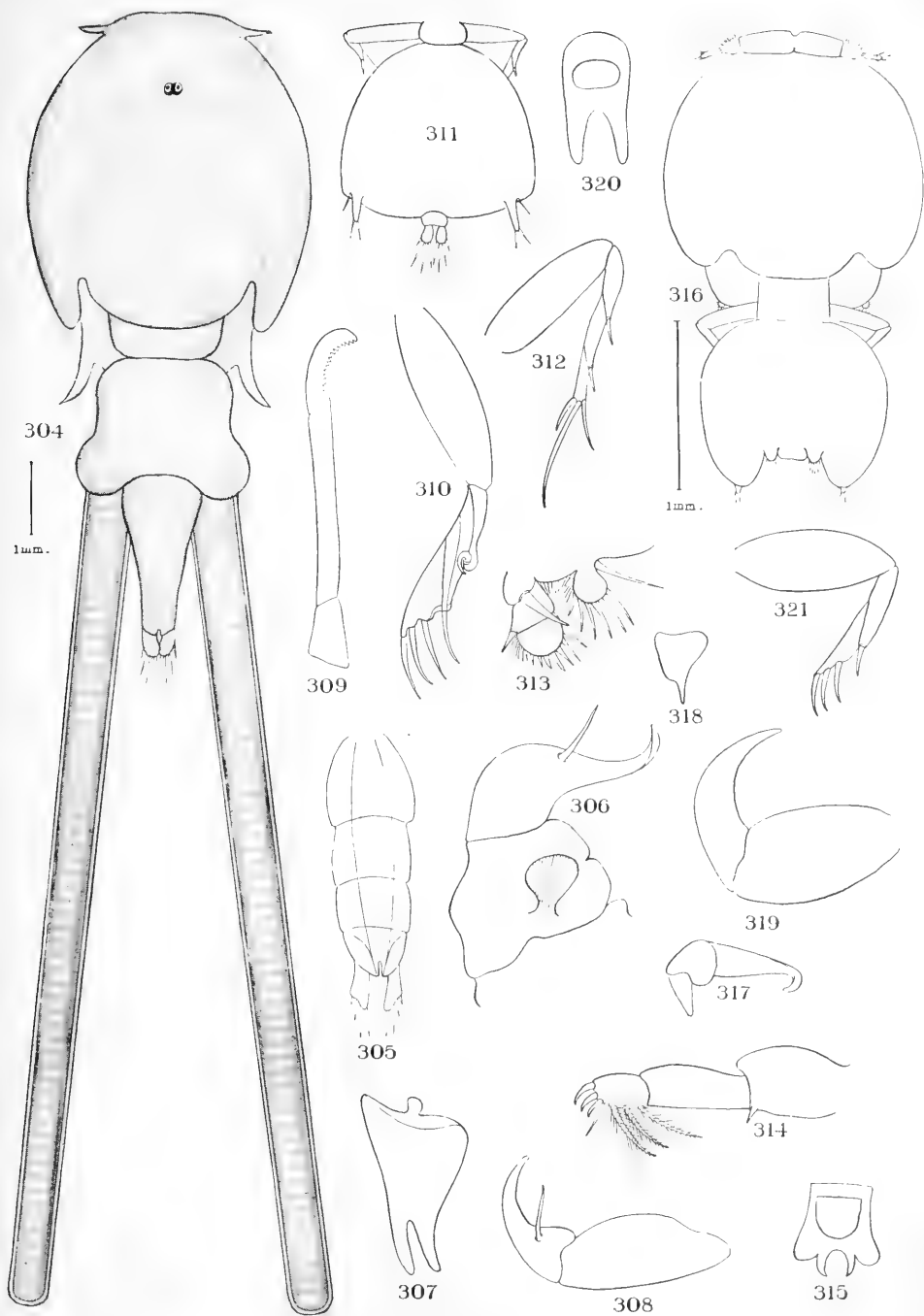
LEPEOPHTHEIRUS PARVIVENTRIS AND LEPEOPHTHEIRUS BIFURCATUS.

FOR EXPLANATION OF PLATE SEE PAGES 671, 672.



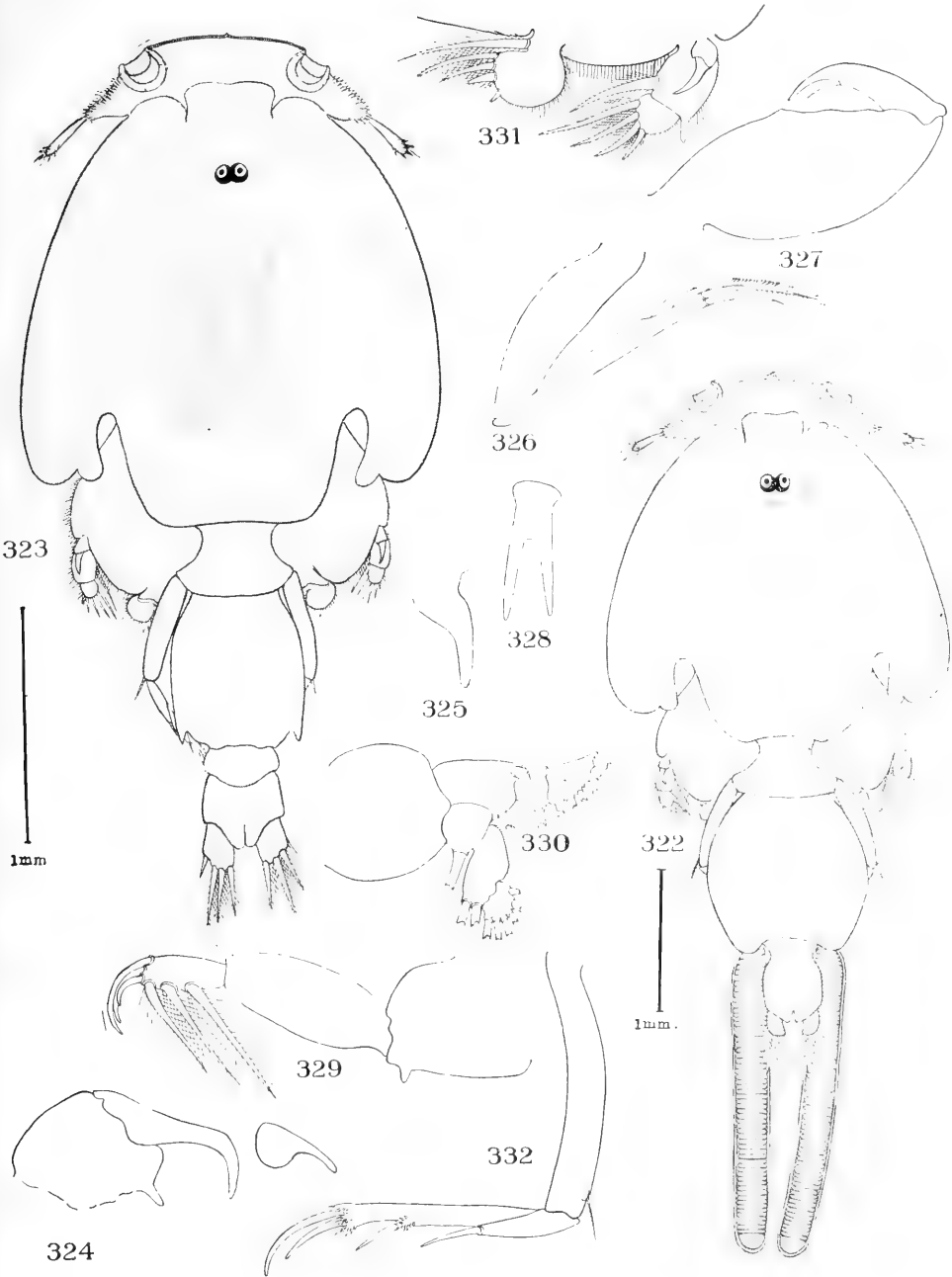
THE MALE AND FEMALE OF *LEPEOPHTHEIRUS SALMONIS*.

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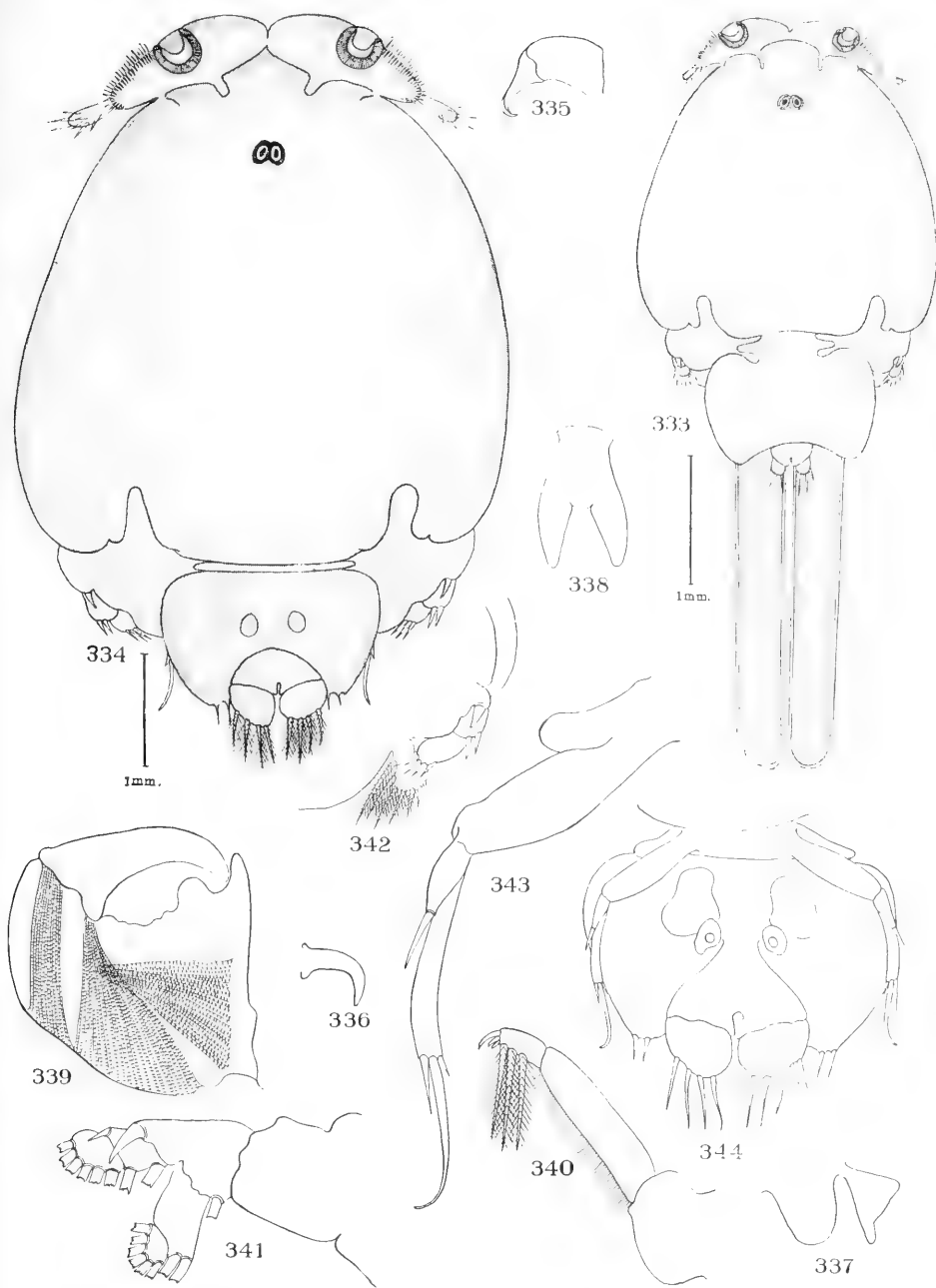
LEPEOPHTHEIRUS SPECIES AND ANURETES HECKELII.

FOR EXPLANATION OF PLATE SEE PAGE 672.



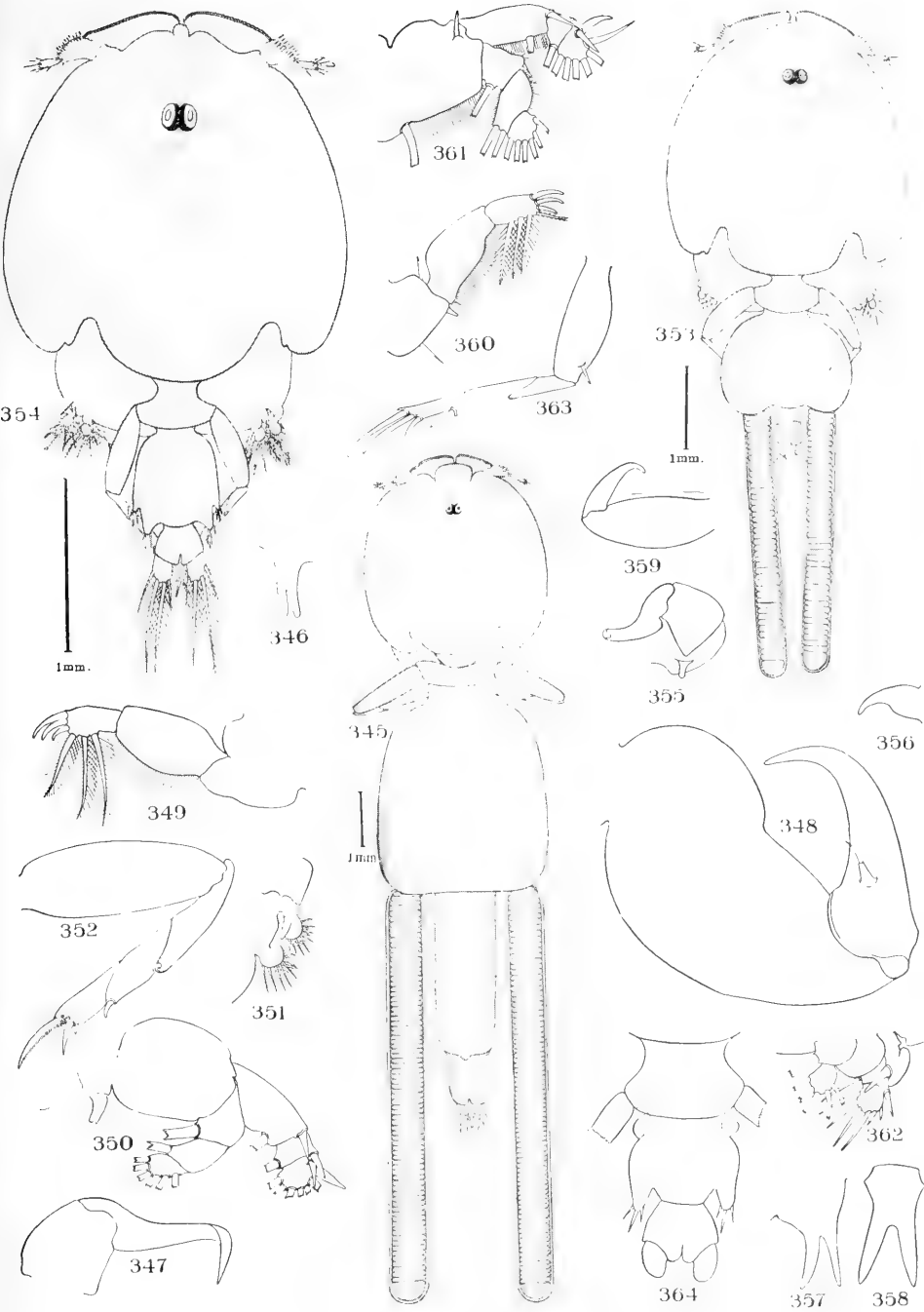
THE MALE AND FEMALE OF CALIGUS TERES.

FOR EXPLANATION OF PLATE SEE PAGE 672.



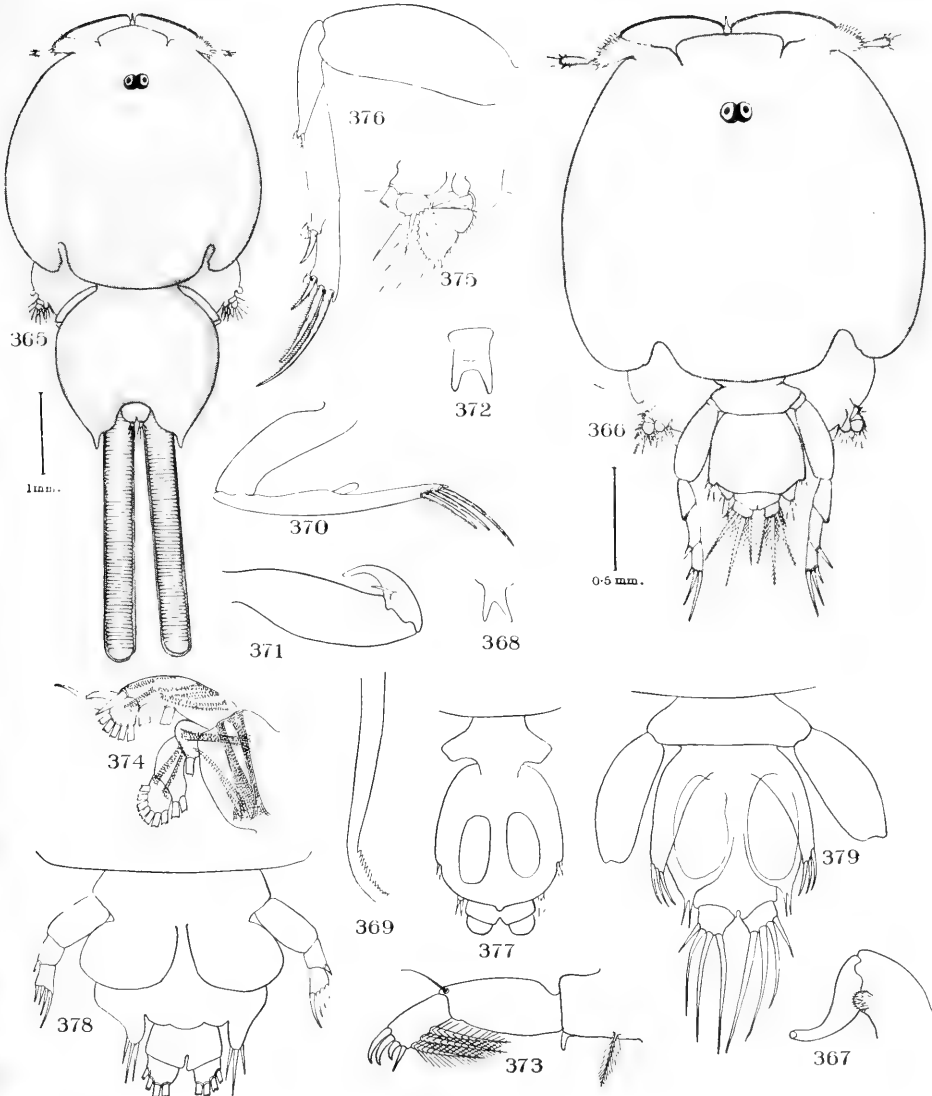
THE MALE AND FEMALE OF *CALIGUS CENTRODONTI*.

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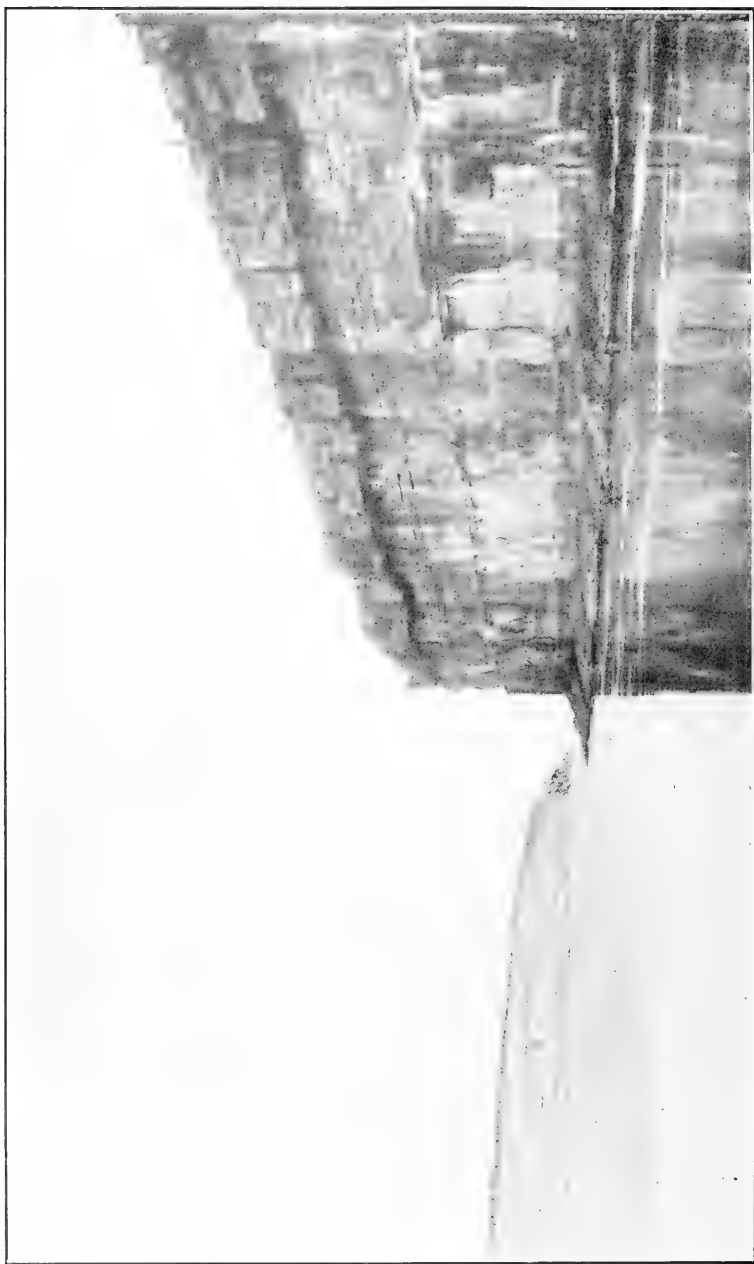
LEPEOPHTHEIRUS INNOTATUS AND LEPEOPHTHEIRUS CHILENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 672.



THE MALE AND FEMALE OF *HOMOIOTES PALLIATA*.

FOR EXPLANATION OF PLATE SEE PAGE 672.



THE RAPIDS, MACKENZIE RIVER.

NOTES ON MAMMALS COLLECTED AND OBSERVED IN
THE NORTHERN MACKENZIE RIVER DISTRICT, NORTH-
WEST TERRITORIES OF CANADA, WITH REMARKS ON
EXPLORERS AND EXPLORATIONS OF THE FAR NORTH.

By R. MacFARLANE.

Chief Factor, Hudson's Bay Company.

Among the reasons which led me to prepare this list and relative notes, together with the paper on the birds and eggs collected by me and under my direction in Arctic America, recently published by the Historical and Scientific Society of Manitoba, and by the U. S. National Museum at Washington,^a the following may be mentioned: First, I desired thus to set an example to the fur-trade officers of the Hudson's Bay Company, which some of them could well follow, to furnish similar experiences of their own. Secondly, I further desired to incite the ambition of others, especially the younger men of the service, stationed at posts on the Gulf of St. Lawrence, on the sea-coasts of Labrador, Hudson Bay, and the North Pacific, amid the fertile prairies and great forests, and on the banks of numerous rivers and lakes of the vast interior of Old and New Canada, to resume and continue making important additions to the company's officers' well-known interesting contributions to the natural history of their former chartered, licensed, and still occupied trade territories. Thirdly, I wished that the Smithsonian Institution might appoint an agent for the purpose of personally reviving the grand work begun by Robert Kennicott in 1859, and afterwards followed by others, under the auspices of the lamented Spencer Fullerton Baird. Lastly, but not least, I trust that both papers may eventually aid in arousing the naturalists of Canada to exert themselves more fully than ever, not only in the way of ascertaining the existence of new species and the geographical distribution of others, but also in obtaining specimens to fill up the many gaps in the catalogues of well-known animals which are still unrepresented in their national museums.

^a Proc. U. S. Nat. Mus., XIV, 1892, pp. 413-446.

In its immense northwest territories, situated on both sides of the Rocky Mountains, and in the wilds of Quebec, Ontario, Labrador, and Hudson Bay, but especially in the "Great Mackenzie Basin," the Dominion of Canada presents an indubitably rich and varied field for scientific investigation. For many years to come there should be ample room within its continental boundaries (without reference to the important outlying arctic islands and lands which extend almost to the North Pole) not only for her own and other British explorers, but also for like-minded brother-workers from the great neighboring Republic, to make large and valuable acquisitions in all branches of natural history; and if the former would only take hold of this interesting and fascinating subject with characteristic zeal, energy, and perseverance there can be little doubt that before the close of the second

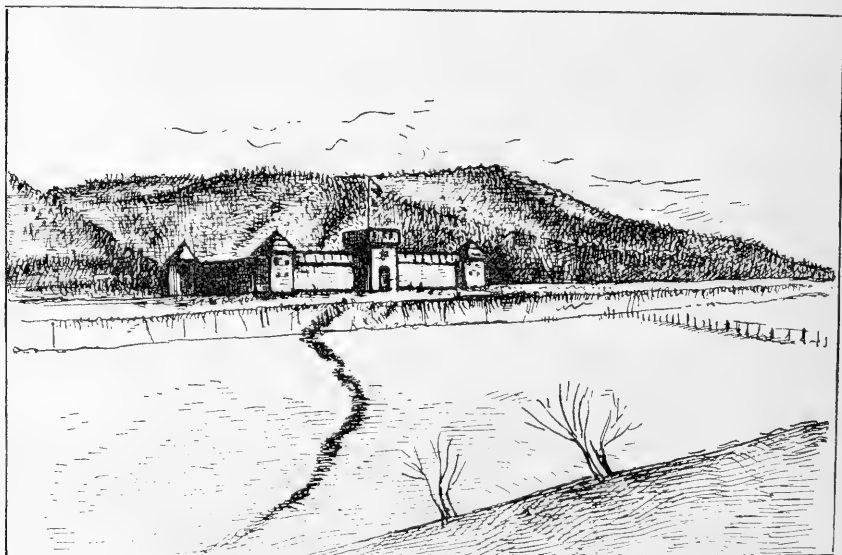


FIG. 1.—SKETCH OF FORT ANDERSON.

decade of the century our great Dominion would find itself in possession of a collection of Canadian objects and species worthy of the country, and in some at least, if not in most, departments of science, second to none in either hemisphere.

"In the month of March, 1865, the Reverend Émile Petitot, at that time Père of the Order of the Maurice Institution of the Good Hope, Mackenzie River Roman Catholic Mission, paid a visit to Fort Anderson, and while there made an excellent winter sketch (subsequently painted in water colors) of the establishment. I forwarded the latter to the Smithsonian Institution at Washington and Professor Baird had it reproduced in, I think, Frank Leslie's Weekly (1865 or 1867), with some relative information. It was on a much larger scale than this sketch copied from Abbé Petitot's *Les Grands Esquimaux*.

The spruce poles, seen in the sketch, with their attached branches and sunk to the bottom of the river through holes made in the ice soon after it set fast, formed a

The scope of country embraced by the following notes is, in the main, the same northern section of the Mackenzie River District referred to in the aforesaid paper on arctic birds and eggs. It is bounded on the north by the Polar Sea, to the outlet of the Mackenzie River; on the east, by the coast of Franklin Bay, from Cape Bathurst to its depth in Langton Harbor; on the west, by the lower Mackenzie River; and, on the south, by the sixty-seventh parallel of north latitude to its intersection with longitude 124° west. The period during which the collections herein mentioned were made extended from the beginning of the year 1861 to the end of July, 1866. Fort Anderson (about

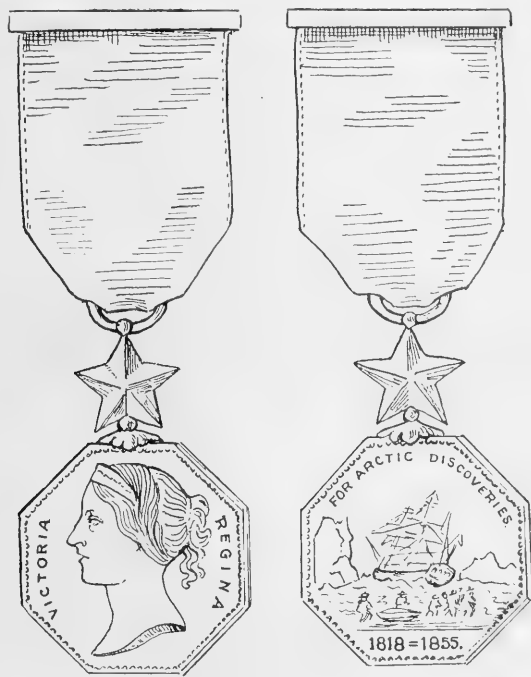


FIG. 2.—THE QUEEN'S ARCTIC MEDAL.

latitude $68^{\circ} 30'$ north, and longitude 128° west) was the principal point of investigation. It was situated on the right bank of the Anderson River, first visited by me in 1857. The Anderson River, which disembogues itself into Liverpool Bay, latitude 70° north, has its sources in the Reverend Abbé Petitot's "Ti-Degale" (Frost-hardened Mountain), lying at some "little distance" to the north of Great Bear Lake. For this exploration and the recovery in June, 1862, of the

barrier from bank to bank, with an open space near the center, in which a net was placed, and by means of which quite a large number of white fish and other fish were annually secured in course of the two or three weeks "run." The other marking on the ice is that of a dog meat-hauling and Indian winter track to the country lying across the Anderson River to the west of the fort.

dispatches delivered to the Eskimo by Capt. Robert McClure of Her Majesty's arctic search expedition ship *Investigator*, when off Cape Bathurst in the month of August, 1850, for transmission to England by way of Fort Good Hope and other Hudson's Bay posts, the British Admiralty (through the good offices of Lord Stratheona and Mount Royal, G. C. M. G.) were recently pleased to award me the Queen's arctic medal. When Sir Leopold McClintock returned to England from his expedition of 1857-1859, which ascertained the fate of Sir John Franklin and his companions, an octagonal form of the medal was struck for presentation to several of his officers and crew who had not received the round service medal of 1818-1855 previous to the latter date.

Although these notes chiefly relate to the collections made by the writer within the above-defined region, and at two or three other points, yet many incidental references were deemed necessary in respect to northern mammals obtained and observed by officers of the Hudson's Bay Company and others in the Mackenzie River District and elsewhere. It was also considered advisable to refer to similar work performed by officers of some of the British Government's arctic exploring and search expeditions which wintered in Dominion Polar Sea lands. Brief extracts have also been made from Gen. A. W. Greely's *Three Years of Arctic Service*, and from other land and water exploring publications, while the explanatory remarks, called for under each species of animal entered in the company's catalogues of their annual London fur sales, practically include every noticeable vantage point of observation throughout the vast domain in which their trade and commercial business has been conducted, particularly during the last eighty-two years.

With such a magnificent field for investigation as the "Anderson," as well as other interesting points throughout the vast regions in which he was stationed as a post and district manager for a period exceeding forty years (1852-1894), the writer of these notes has since deeply felt and regretted that, despite the many advantages pertaining to his position as a company's officer, he has not (except at Fort Anderson) done a quarter as much as a collector and observer as he might and ought to have accomplished in ascertaining and making known to naturalists the copious wealth of the animal kingdom in the northern lands of his adopted country.

It may be here premised that this paper was largely prepared for publication at Cumberland House, the headquarters of Cumberland District, early in the winter of 1890-91, but for various reasons it was not completed at that time, while, unfortunately, several sheets thereof, together with some relative memoranda, have since disappeared, and this will explain the paucity of the remarks appearing under certain species headings. Quite a large number of the speci-

mens of mammals which had been collected were lost or much injured by neglect on the part of their Indian and Eskimo collectors, or from various causes beyond careful control. The nomenclature of the following list has been carefully revised by the naturalists of the U. S. National Museum.

UNGULATA.

MOOSE.

Alces americanus (Clinton).

This valuable food animal used to be very numerous on the Peace River, and, indeed, throughout the forest region of the northern portion of the "Great Mackenzie Basin;" but for the last twenty years it has been much less abundant, and, indeed, remarkably scarce in many parts, especially along the Athabasca, Peace, Liard, and other rivers, and the larger lakes of the North. As moose have since been found more or less plentiful in the eastern, western, and southern sections of territory where for many years previously they were rather rare, or conspicuous by their absence, it is now supposed by some observing natives and others that considerable numbers of them must have migrated southward, particularly during the remarkably mild winter of 1877-78. Be that as it may, it has been noticed that at intervals, and for several years at a time, this animal has been rather scarce in various sections where it had formerly been fairly abundant. It is easily scared, and no doubt much hunting ultimately succeeds in driving it away to distant and less accessible retreats. Previous to the establishment of Fort Anderson, in 1861, moose were frequently seen by us on our annual winter trade trips from Fort Good Hope to (the Eskimos of) Liverpool Bay, feeding along the high sloping banks of the Anderson River, but they soon after diminished in numbers, and had already become somewhat difficult to discover when the post was abandoned, in 1866. They are, however, to be found sparsely there to the very edge of the wooded country, especially in sheltered river valleys. Traces were observed by us near the Wilmot Horton River in the Barren Grounds, in about latitude 69° north and longitude 126° 30' west. I may also mention that on my way back from a visit made to Anderson River in July, 1860, I came across and traveled through a veritable moose preserve of some extent, which lay between the usual hunting grounds of the Loucheux of Peel River and the Hare Indians of Fort Good Hope. Several moose were seen and one shot, while traces of them were very numerous. It was also the resort of many black bears and woodland caribou. Again, for nearly a decade subsequent to 1865 (in that year Fort Nelson, which with all its inmates had been utterly destroyed by the Indians in 1813, was reestablished near its former site on the eastern branch of the Liard

River), moose were much more abundant in the adjacent country than they have ever been since. In the vicinity of farming and ranching settlements, however, they would seem to have become somewhat accustomed to the not distant presence of man, as is surely evidenced by their comparative abundance still in the eastern sections of the province of Manitoba (and elsewhere), although they have been much hunted there of late years. No doubt the close season and the due enforcement of the relatively restrictive killing law have been important accounting factors for this state of affairs, which is so satisfactory not only to naturalists and sportsmen but also to other interested residents.

During summer, when the weather is warm and mosquitoes very troublesome, moose resort for protection to the shores of lakes and streams, and while standing in the water they sometimes seem quite indifferent to the near presence of man, and will then retire only after being repeatedly fired at. I myself had proof of this on one occasion when ascending the Anderson River in the end of June, 1866. There were five or six in the party when we observed three full-grown moose in the water. As they were not in good condition, we did not care to kill them, but, in order to test the truth of this peculiarity, I made the Indians fire a number of shots very close to them, but to no purpose. In fact, we had to scream and yell at them before they got out and stalked away at a very leisurely pace. According to a consensus of Indian reports from various quarters, the moose copulate annually during the months, or moons, of September and October, and the offspring appear some nine months later. The female generally selects a dense thicket on a lake island or islet, or in a clump of trees on a dry spot in the midst of a marshy swamp or other submerged tract of forest, for the purpose of bringing forth her young, which are usually one or two, and occasionally, it is said, as many as three, in number. At birth, the hair-covering is very short and of a dirty-yellowish color, the eyes are open, and the newcomer is rather weak and helpless; but, after a comparatively short time, it is able to move about and soon becomes quite active. Suckling is supposed to continue for two or three months. When in good condition and stalked, the flesh of the moose is excellent eating and, on the whole, more tender and luscious than the venison of the red deer or either species of caribou; but animals killed after a long chase on snow, or during, or after the rutting season are far from palatable, owing to a strong and very rank flavor then acquired. The skins are dressed by native women and the resulting smoked leather is made into tents or lodges, moccasins, tunics, shirts, and trousers for winter and summer use by the resident population of the interior. Some skins are also cut up for pack cords and others turned into parchment for the requirements of the Hudson's Bay Company and others. Hunters assert that hermaphrodites and barren females are sometimes met with, and that these imperfect exam-

ples almost invariably attain a larger size and heavier weight than their fertile kindred. Chief Trader H. I. Moberly, an experienced officer, hunter, and woodsman, confirms the truth of this statement from his own personal observation. In his North West Passage, Doctor Armstrong mentions that Capt. Sir Robert McClure, one of a small party of explorers sent out in the spring of 1851 from Her Majesty's Franklin search-expedition ship *Investigator*, then wintering in Prince of Wales Strait, said that he saw three animals which he firmly believed to be moose in about latitude 71° north and longitude 114° west. I think this is the first and only record of this animal having been met with on the lands lying to the north of the American Continent.

Chief Trader James Lockhart has recorded that "the moose down at Peel River and Fort Yukon are much larger than up this way [Great Slave Lake and Fort Simpson]. There, I have known two cases of extraordinary moose having been killed [probably one or both were obtained at Peel River], the meat alone of each of them weighing over 1,000 pounds. The Loucheux have a superstition that the Indian who meets with one of these extraordinarily large moose is sure to die within the year, or else meet with some grievous misfortune".^a

The above may belong to the gigantic species recently discovered on the western coast of Alaska, or they may be representatives of those referred to by Mr. Moberly. I have never met any of these monster moose, although of course I have seen examples weighing considerably over the general average.

WOODLAND CARIBOU.

Rangifer caribou (Gmelin).

I do not think this species extends much beyond latitude $67^{\circ} 30'$ north, except perhaps in spurs of the Rocky Mountains to the west. It is a larger animal than the Barren Ground reindeer, and is not met with in the "barrens" proper, nor on the shores of the Polar Sea. Like the latter, the females produce one or two fawns in spring. The rutting season, as well as the period of gestation and time of birth, are said to be much the same as in the case of moose. The eyes of the young are open when born, the skin is light brown, and they soon become quite lively and strong. They are suckled for several months. The skin of the woodland caribou is dressed by the native women and afterwards made into necessary moccasins, gloves, tunics, and trousers, and sometimes women's dresses. Those cut by the gaddly are converted into "babiche" for lacing snow-shoes, and occasionally into thongs of various thickness, which were formerly, if not now, twisted into snares for capturing deer. Herds of the

^a Proc. U. S. National Museum, XIII, 1890, p. 307.

woodland species seldom exceed thirty or forty individuals, except in the autumn, when sometime quite a large number congregate together. They do not associate with the Barren Ground reindeer, and seldom quit the forest country. Although known to exist at no great distance to the south, we never, to my knowledge, received at Fort Anderson an example in the flesh, except the ribs of a few in a dried state; but in course of my six years' charge of Fort Good Hope (latitude 66° 16' north), the Hare and Nahanni Indians frequently supplied the establishment with a number of dressed skins and a considerable quantity of the venison of this animal. A similar remark would apply to my five years' residence at Fort Simpson (latitude 62° north, longitude 122° west); but although the species is fairly distributed throughout New Caledonia district, British Columbia, we seldom obtained any of its meat or preserved skins during my two years' charge. It is not uncommon in the Athabasca and Peace River districts, nor at Cumberland House, Saskatchewan, where we occasionally received some venison and skins, while I was stationed there in 1889 to 1894. It is not improbable, however, that the variety of woodland caribou found in the Rocky Mountains of northern Canada may belong to the mountain caribou discovered in the Selkirk Range of British Columbia and made known to science by Mr. Thompson Seton in 1899. It is said to be darker in color than Maine and other eastern specimens.

BARREN GROUND REINDEER.

Rangifer arcticus (Richardson).

Although this interesting animal has of late years been very irregular in frequenting ancient passes and haunts in the forest country, and in numbers very considerably less than formerly, yet it is believed to be still very numerous in the "Mackenzie Basin." The northern Indians were accustomed, in the face of repeated remonstrances on the part of the company's officers and resident missionaries, to slaughter thousands of reindeer annually, chiefly for the skins and tongues, and too often from the sheer love of killing. But as they have latterly experienced protracted spells of food scarcity and even actual starvation, I believe it has taught them to be more careful and provident. Since the introduction of steam also into the districts of Athabasca (1883), and the Mackenzie River (1886), the provision posts of both have not been called upon to furnish more than a bare quota of the quantities of dried meat and pemmican absolutely required under the old inland York boat system of transportation. The hunting of reindeer has, therefore, largely declined, no doubt to their increase in numbers, and the Indians are able to devote more of their attention to the trapping of fur-bearing animals. The Eskimos of Anderson and Mackenzie rivers, however, were never guilty of waste of food in the

same inexcusable manner. They are a more provident race, and seldom suffer privation for want of food. In course of the company's five years' occupation of Fort Anderson, we received considerable quantities of venison and many skins of the Barren Ground reindeer from the Eskimos and Indians who resorted thereto for purposes of trade.

During the comparatively short season of open water, the Anderson and Liverpool Bay Eskimos were engaged in fishing and hunting reindeer along the river, as well as walrus, seals, and sometimes whales in the contiguous polar seas. In spring, when the reindeer were on their annual migration to the coast, but especially on their fall return to the woods, the Eskimos shot and speared a great number; in the former season while browsing on the slopes and summits of the Anderson River banks, and in the latter, when in the water making for their customary crossing points or passes. In both cases, the successful hunter inserted an arrow in the carcass, so that on its floating by the lodges lower down the river it might be taken ashore for the benefit of the party by whom it had been killed. Early in December, the Eskimos usually retired to their driftwood-constructed huts, or winter houses, at various points along the coast, but before doing so they always made more or less provision for their return to the Anderson River in the beginning of the succeeding month of April, by placing in one or more caches (built on and formed of large blocks of thick ice, well protected from wolves and wolverines, the chief robbers to be feared) some 30 or 40 miles from its outlet in Liverpool Bay, a considerable quantity of fresh venison. Early in March, the female seals begin to bring forth their young, and the seal then became the chief object of chase by the Eskimos, who, as the days lengthened, moved out seaward on the ice from their winter residences on the coast to engage in the interesting task of hunting seals. After reaching the aforesaid caches, the bulk of the Eskimos would remain in the neighborhood, using the meat, trapping foxes, and killing a few reindeer and making the usual preparations for the summer season, until the disruption of the ice, when many of them would ascend the river, visit the post, and spend some days in its immediate vicinity, and in due time proceed to the seashore.

When I first reached the mouth of the Anderson River, early in February, 1859, instead of a village, as I was led to expect, there was but one large house inhabited by fifteen men, women, and children, while the nearest group of huts was, as they informed us, at too great a distance for us to visit in the very cold and stormy weather which usually occurs at that season, and which, indeed, prevailed during our two days' stay there. Our party comprised one Scotchman, one Swede, one French half-breed, and one Loucheux Indian, with two trains or teams of three dogs each. We found our quarters very warm and comfortable. Fort Anderson was established in 1861, after we had

made several more winter trips to the same house, as well as to the spring provision rendezvous on the ice, already mentioned. By the autumn of 1865, however, several new huts were built at intervening distances from there to within some 60 miles from the post. This was done at my request, and their occupants met with some success in trapping foxes and minks, with a few martens, in the wooded ravines farther south. On this and subsequent winter trips to the coast, we observed fresh traces of reindeer, while the Eskimos informed us that some animals were occasionally seen, and a few shot, most every winter, very close to the ice-covered sea. The Fort Indians usually snared a number of reindeer in spring and summer, but their big annual hunt was made in the fall, when they frequently shot and speared them by the hundred. During the winter season they always succeeded in killing a few individuals now and then, but more, of course, when the snow happened to be deeper than usual.

When the fall of snow is light and the weather severely cold, the reindeer are almost constantly on the move, and are then very difficult of approach. At such times, especially when rabbits are scarce, the "caribou-eating" Indians frequently suffer much privation for want of food while following them for a living in their winter peregrinations. The skin of the reindeer furnishes the Eskimos with nearly all of their summer and winter clothing. The hair or fur is never removed in this connection; the made-up skin of the fawn forms the inner shirt, with the fur side next the body. (The skin of the musquash is sometimes used in a similar manner.) The outer tunic, shirt, or capote, with hood attached, is made from selected portions of adult late summer or early fall skins, with the hair outside and having the borders trimmed with a thin strip of the fur of the wolf or wolverine. A sufficient number of similarly scraped but undressed skins are sewed together and mounted on poles to form a summer tent or lodge, and also for sleeping robes or blankets for personal and family use. These robes are as flexibly prepared as the tunics, and are very comfortable on a cold, windy night. The Indians are also generally indebted to the reindeer for winter robes and capotes, and likewise for tents and dressed leather for making moccasins, gloves, tunics or shirts, trousers, game bags, and women's and children's clothing. Certain inferior and many fly-cut skins are converted into "babiche" for lacing snowshoes, and other suitable skins are made into deer snares and parchment for windows, while the tendons of all are split and twisted into fine and excellent thread for general use.

The remarks made under *R. caribou* in respect to the number and appearance of the young at birth, etc., are equally applicable to this species. I may here remark that albinos are very rare among the northern deer. In 1886 I obtained a fine example, which was forwarded to the Smithsonian Institution at Washington. It had been

killed the previous winter by an Indian near Fort Chipewyan, Lake Athabasca, but, although I heard of a few instances elsewhere, I think this was the only one I ever saw in the interior. The company generally exports a number of reindeer in a parchmentary and Indian-dressed state, which seldom realize more than their actual cost. In the years 1902 and 1903, respectively, they sold in London 321 and 267 reindeer skins.

Doctor Armstrong, of the *Investigator*, writes that besides several white bears, musk oxen, and other polar animals herein referred to, the hunters of that ship, while wintering in Prince of Wales Strait, saw a number of reindeer, though they failed to secure even one. In Mercy Bay, latitude $76^{\circ} 6'$ north and longitude $117^{\circ} 55'$ west, however, where it was finally abandoned on June 3, 1853, the total number of reindeer killed between October, 1851, and April, 1853, was 112. After reaching Melville Island, about latitude 75° north and longitude 109° west, the doctor, with several officers and men of Her Majesty's arctic ships *Resolute* (Captain Kellett) and *Intrepid* (Captain McClintock), shot a large number of reindeer and several musk oxen, the meat of which weighed over 10,000 pounds. After four seasons' experience, Doctor Armstrong came to the conclusion that the reindeer inhabiting Baring Island do not migrate to the southward thereof. In Mercy Bay and Prince of Wales Strait, many individuals and small herds were seen and a number shot during the severest months of the winter. "In May and June the females calved in the ravines and valleys bordering on the coast where the sandy soil mixed with the alluvium forms a rich loam which highly favors vegetation and affords good pasturage for the hungry denizens of its wilds." As reindeer are present all winter on Melville, Baring, and other large islands of the polar regions, I think it may be confidently assumed that there is no migration from them to the continent. On the latter, however, from Port Kennedy (latitude 72° north and longitude 94° west), Bellot Strait, its northeastern extremity, there is apparently a regularly recurring season of migration south and north. There may be a similar annual movement of reindeer between the northern coast and Wollaston Land by way of the Union and Dolphin Strait, and also from Victoria Land to Kent Peninsula by way of Dease Strait. Lieutenant Schwatka and Colonel Gilder observed considerable numbers of them passing over the ice on Simpson Strait late in the spring and early in the winter of 1879 between Adelaide Peninsula and King William Land (Island). General Greely gives latitude $82^{\circ} 45'$ north as the probable highest polar range of the reindeer. An antler and old traces were found on Grinnell Land. Sir J. C. Ross writes that the does arrived at Boothia in April and the bucks a month later, while herds of several hundred were seen in May. He also mentions that "the paunch of the deer is esteemed a great delicacy, and its contents is the only

vegetable food which the Eskimos of that country ever taste." While stationed at Mercy Bay, Doctor Armstrong made "various sectional preparations of the antlers of the reindeer in different stages of growth, as illustrative of its rapidity, in the hope of elucidating one of the most surprising processes of animal growth which bounteous nature enables us to contemplate as evidencing her wonderful reproductive powers." Unfortunately for science, however, these specimens, together with a fine collection of birds, mammals, and other objects of natural history, were left behind along with the abandoned ship *Investigator*. As already mentioned, a number of hardy reindeer bucks remain all winter near the arctic coast of the lower Anderson in Liverpool Bay.

Statement showing the yearly migration of the Barren Ground reindeer from the north, and their spring return thereto, as observed at the Hudson's Bay Company's post of Lac du Brochet, Reindeer Lake, 1873 to 1890.

Season.

1873.

None were observed passing the neighborhood of the post.

1874.

May 9. First deer seen on their spring migration to the north.

Nov. 14. First deer seen on their yearly return from the north.

1875.

Apr. 26. First deer seen on their spring return to the north.

Oct. 27. First deer seen on their autumn return from the north

1876.

May 17. First deer seen on their spring return to the north.

Oct. 29. First deer seen on their autumn return from the north

1877.

Apr. 21. First deer seen on their spring return to the north.

Dec. 28. First deer seen on their autumn return from the north.

1878.

Apr. 27. First deer seen on their spring return to the north.

Nov. 12. First deer seen on their autumn return from the north.

1879.

Apr. 24. First deer seen on their spring return to the north.

Nov. 18. First deer seen on their autumn return from the north.

1880.

May 12. First deer seen on their spring return to the north.

Nov. 26. First deer seen on their autumn return from the north.

1881.

Apr. 22. First deer seen on their spring return to the north.

Oct. 24. First deer seen on their autumn return from the north.

1882.

Apr. 26. First deer seen on their spring return to the north.

Dec. 15. First deer seen on their autumn return from the north.

1883.

Apr. 26. First deer seen on their spring return to the north.

Nov. 6. First deer seen on their autumn return from the north.

1884.

May 1. First deer seen on their spring return to the north.

Season.

1885. None were observed within many miles of the establishments.
 1886. None were observed in the spring or autumn of this season.
 1887. None were observed in the spring or autumn of this season.
 1888. None were observed in the spring or autumn of this season.
 1889. None were observed in the spring of this year.

Dec. 21. First deer seen on their autumn migration from the north.

1890.

Apr. 16. First deer seen on their spring migration to the north.

ROCKY MOUNTAIN GOAT.

Oreamnos montanus (Ord).

The Nahanni tribe of Chipewyan, or Athabasca, Indians of the Mackenzie River District kill a number of these goats annually in the northern ranges of the Rocky Mountains; but it is perhaps remarkable that no wild sheep or goats are met with in even the most extensive spurs thereof, situated on or to the eastward of that great river. They extend, however, north to the Arctic Circle, if not beyond. At Forts Norman and Good Hope the company frequently receives small quantities of the dried meat of this animal from their Indian hunters on the west side of the river and in the mountains.

DALL'S MOUNTAIN SHEEP.

Ovis dalli (Nelson).

It is probably this recently-determined variety, or species, of wild sheep which inhabits the Rocky Mountains of the lower Mackenzie River to the arctic coast, while the true Bighorn, *Ovis canadensis* Shaw, exists in the ranges to the south. Some of the western Eskimos, who occasionally resorted to Fort Anderson, wore outer coats or capotes made from the skin of this animal, with the hair attached. The Nahanni tribe of Indians belonging to the company's northern posts of Nelson, Liard, Simpson, Norman, Good Hope, Peel River, and La Pierre House usually brought in for trade, small supplies of the meat of the goat and sheep of the Rockies in a partly smoked or sun-dried state. We always considered it, when in prime condition, second to no other variety of flesh food to be had in that extensive territory.

MUSK OX.

Oribos moschatus (Zimmermann).

This interesting member of the family Bovidae has not, so far as I am aware, been discovered in the flesh to the westward of the Mackenzie River, nor, as a rule, are many met with in the tract of country lying to the eastward between that stream and the Anderson. Mr. P. Deschambeault distinctly remembers having, upward of fifty years

ago, seen his first musk-ox skin at Fort McPherson, Peel River, then in charge of his father, Chief Trader George Deschambeault. It had probably been taken from a straggler by an Indian on the east side of the Mackenzie River. In the "Barrens" proper, however, as well as along the arctic American coast, and on the borders of, and for a short distance within the northern forest region to the southeastward, in winter, musk oxen are fairly, though in no one place or section very numerous. In fact, very few were ever observed by us on any of our several specimen-collecting tours from Fort Anderson to Franklin Bay, or on any other of our many summer and winter journeys within the Arctic Circle.

On one occasion, however (July 4, 1864), on our way back from that bay, we saw a herd of twenty-five animals of various ages reposing on the side (and just below the summit) of a gentle eminence in the Barren Grounds. A patriarchal-looking bull on the top of the eminence evidently kept guard, while the others appeared to sleep. I had been for some time endeavoring to obtain a pair of live calves for shipment to London and as this seemed a good opportunity for making an attempt in that direction we rapidly advanced to about 300 yards from their position, when we halted and unloaded our twelve Eskimo pack-carrying dogs and sent them at the herd, while several of the fastest sprinters in our party of twenty followed as closely as they could. As soon as the dogs were perceived, the sentinel gave the alarm and the musk oxen immediately set off in different directions, apparently very much startled, but when the dogs began to bark the musk oxen rallied instantly, came together, and presented a rather formidable front to their assailants. This military-square-like formation on the part of the musk oxen seemed to have a rather terrifying effect on our dogs, as they almost ceased to bark, though now within a few yards of the herd. In the meantime we were all rapidly nearing the herd, and I was in hopes that with our dogs we might be able to surround or run down and capture one or more of the several spring calves observed. When they became aware of our near presence—the close proximity of the dogs (who resumed their barking) having taken up their attention—by the premature firing of a shot which fatally wounded one of the larger animals they all scampered away at such a sweeping canter that we soon gave up the chase as hopeless, although our dogs continued to follow them for some time, but later returned to partake of the spoil of the killed animal. After skinning the three-year-old male, we noticed a moving object at some distance, which we supposed to be one of the dogs, but it turned out to be a spring calf which had evidently swerved from the main body and was doubtless searching for its mother. Several of the party thereupon started out with the dogs in full pursuit, and we all had to show our best paces for several hundred yards before we could

reach the spot where he was brought to bay. We at once secured him by means of a looped line, but not before he was wounded by the dogs. We had much trouble in getting the calf to accompany us—in fact, we first let him rather exhaust himself in bucking and kicking like a goat, while he stubbornly refused to be led by a line. After a time, when prodded from behind, he would make a rush at his leader, but he eventually quieted down and followed the Indian to the camp. Next day he seemed rather subdued and gave no trouble, not even when being carried across the Wilmot Horton River, but to my deep regret he died at sunrise the following morning, having no doubt bled to death internally. On reaching Rendezvous Lake, near the end of the eastern limit of the woods, my disappointment was great when I learned that a female spring musk-ox calf, which had shortly before been secured for me by an Anderson River Indian, had been killed by dogs during the previous night. Subsequent attempts in the same desirable direction unfortunately failed, and the field is therefore still open for the successful efforts of some favorably circumstanced and luckier party.

On another occasion (June 29, 1865), near the Wilmot Horton River, we shot a large bull which was grazing on a flat plain bordering on a small stream named Eagle. After approaching him we unloaded our dogs and they soon surrounded and began barking at him, a course which he resented by endeavoring to impale one of them on his sharply curved horns, but just as we were coming within gun range he noticed us and at once made off at full speed. It was surprising to witness the seemingly easy, but really swift, gait at which this rather short-legged and clumsy-looking beast ascended a somewhat steep hill in front of him. A long and well-directed shot, however, suddenly ended his career. The beef proved acceptable to the men and dogs, and it neither smelled nor tasted of musk, as it often does later in the year, but especially during the rutting season when it is scarcely eatable except by natives and a few of the company's servants blessed with strong appetites and good digestive powers. The hide was secured, but the skin was so dilapidated, owing to the thick inner coating being still unshed except in large ugly patches, that it was useless as a specimen.

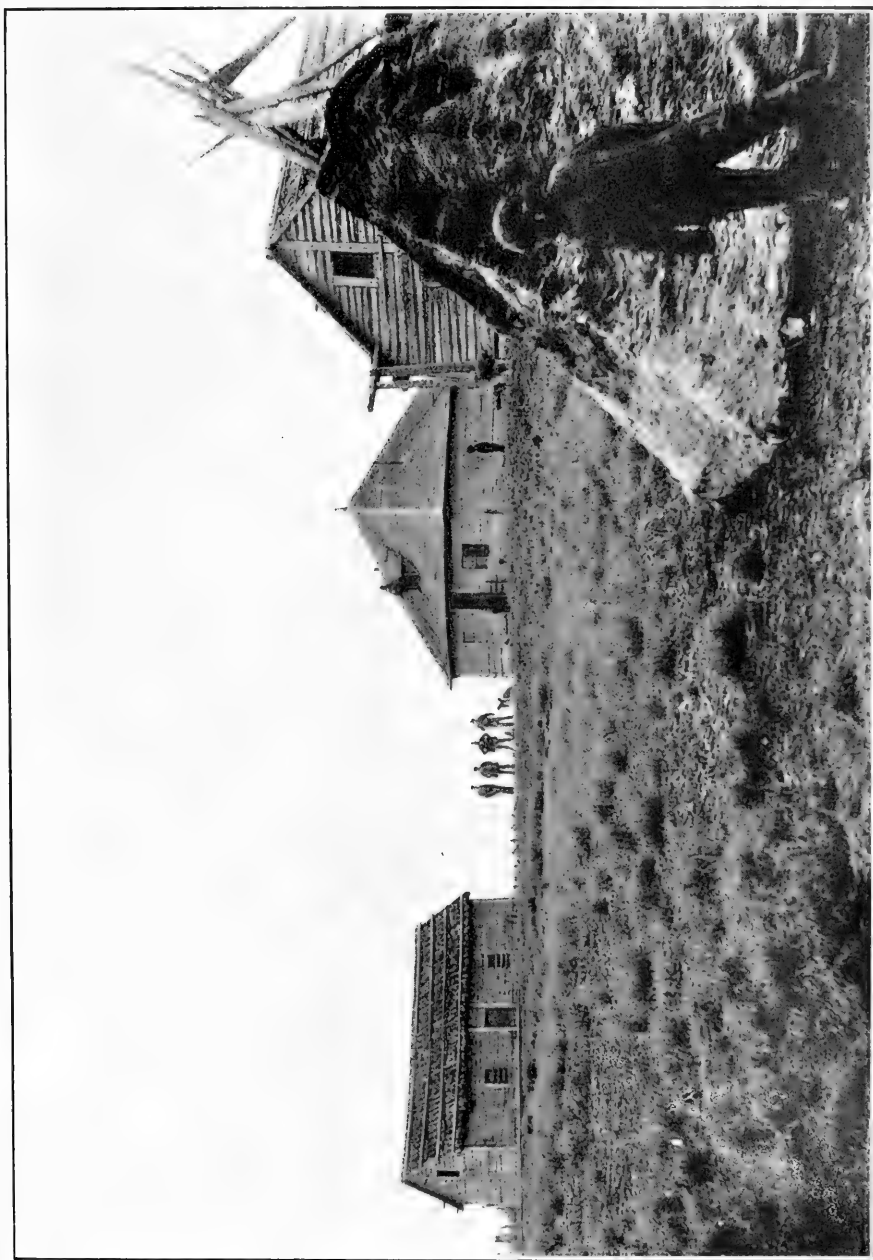
During the severe cold of winter, the musk ox enters the outer sections of the forest and is frequently found therein to a distance of 40 or 50 miles, while we have heard of more than one instance where a stray animal had been killed at fully 100 miles from the nearest "Barrens." The most southerly wandering of the species beyond the limits of its normal range is that recorded by Mr. Preble in *North American Fauna*, No. 22 (1902). A pair was seen on the "Barrens" between York factory and Fort Churchill in about latitude 57° north, and the male was shot. This authentic information was obtained by

Mr. Preble from Dr. Alexander Milne, factor, Hudson's Bay Company, Winnipeg.

The northern range of the musk ox is truly polar. Nearly every wintering arctic expedition has met with them singly or in small (never in large) herds. Former traces have also been observed at many northern points, while on one occasion a traveling party on Melville Land (Island) saw a pure white individual among a comparatively large herd—probably the only instance of the kind on record. Between September 3, 1852, and September 9, 1853, the hunters of Her Majesty's arctic ship *Resolute* shot 114 musk oxen on Melville Island, a clear proof of itself that they are fairly abundant in that locality. Doctor Armstrong, of the *Investigator*, says that in Prince of Wales Strait five, and during his stay in Mercy Bay, Banks Land, two full-grown animals were killed. Several were also shot by himself and Lieutenant Pim on Melville Island. In 1875-76 Sir George Nares, of Her Majesty's exploring ship *Alert*, who wintered in latitude $82^{\circ} 27'$ north, longitude $61^{\circ} 22'$ west, secured quite a number of animals. The first herd seen consisted of a veteran and two young bulls and four old and two young cows. They were all surrounded and, with the exception of the first-mentioned, which required several bullets to finish him, were easily killed. Nares refers to the fact that in 1872 the crew of the American expedition ship *Polaris* shot twenty-six animals on the opposite side of Kennedy Channel during the twelve months passed by them in that latitude.

Markham remarks that "musk oxen ascend hills and climb over rocks and rough surfaces with great ease." He further adds that "they are very irascible when wounded, and will sometimes attack a hunter and seriously endanger his life." Doctor Armstrong has also recorded an interesting experience in Prince of Wales Strait in which the dam and sire of a small herd brought to bay bravely stood in front protecting the others in the rear, an action which surely afforded strong proof of their affectionate instinct. On this occasion three males, the mother, and a young female calf were all shot. Sir Leopold McClintock, who had been engaged in several Franklin search expeditions, writes:

The white cow (the albino observed on Melville Island) was accompanied by a black calf. The musk ox clambers up the steepest rocks like a goat, and, when running, his long black hair heaves up and down, streaming in the breeze, and gives him a peculiarly savage appearance. It is so long that he occasionally treads thereon, and one finds hairs almost 2 feet in length stamped into the snow. There is an undergrowth of very thick wool so soft and silky that the warmest gloves have been made of it. The musk ox is not absolutely deficient of a tail, but it never exceeds $1\frac{1}{2}$ inches in length. They do not seem to cross from one island to another, as the reindeer do, but usually roam about in small herds. Unaccustomed to man, they seldom deigned to notice us until we came tolerably near; then they would gen-



FORT MCPHERSON ON PEEL RIVER.
The most northerly post of the Hudson's Bay Company

erally close together in an attitude of defense. While facing you their massive horns so effectually shield every vital part that it is useless to fire, and therefore a single sportsman must wait until their patience is exhausted and they alter their position; but it is desirable to get behind a block of glassy ice, a rock, or some rough ground, where they can not charge straight at you, which we have known them to do before, as well as after being fired at. I once came across a solitary old bull which instantly faced me, spent a few seconds rubbing his horns against his fore legs (a sure sign that mischief is brewing) and rushed on me at full speed; but I had taken the precaution so to approach him that I was able to shoot him when he halted on the brink of the ravine down which I had retreated.

McClintock further says that three or four sportsmen may station themselves about a herd at a distance of 70 or 80 yards, and then pick off the restless ones first, which so greatly bewilders the remainder that they are easily secured. He was himself one of three who thus shot down a herd of ten in three or four minutes. No wonder, therefore, that he ardently longed for a similar experience at Fort Kennedy, as it would have furnished the crew of his vessel with fresh meat every day for three months, but unfortunately not an animal could be seen. In the vicinity of Fort Conger, Lady Franklin Bay, Grinnell Land, in latitude 81° 44' north and longitude 64° 45' west, General Greely, U. S. Army, commander of the American expedition, secured 103 examples of the musk ox. He gives latitude 83° 3' north as the highest point where traces of this animal were observed by Lieutenant (Captain) Lockwood.

One or two writers have said that lichens form an important item in the diet of the musk ox, but Greely is positive (and I agree with him) that none of his party ever observed them eating any, while the stomachs of a large number examined by him did not contain a trace thereof. The contents clearly demonstrated that they fed on dwarf willow, saxifrages, and grasses. They use their hoofs in digging for these when the ground is covered with snow. There must, however, be fairly good pasturage in certain fertile spots amid the generally desolate and sterile lands situated in high latitudes, similar to that described by Doctor Armstrong as occurring on Baring Island, or it would be utterly impossible for reindeer and musk oxen to subsist there, as many do all the year round. Of course, no such food scarcity exists on continental America, even in the so-called "Barren Grounds." Like all wild animals, the musk ox in winter quenches its thirst by eating snow.

As spring advanced, the musk oxen of the Anderson country migrated northward. The females are said to produce one, and sometimes two, at a birth. The company's posts at which skins are usually traded are Fort McPherson (from the eastern coast Eskimos), Forts Good Hope and Norman (from the Anderson Eskimos and from post Indians who specially hunt them), Rae and Resolution on Great Slave Lake (from Indian hunters), Lac du Brochet, Reindeer Lake (from the

inland Eskimos), and Fort Churchill (from the Hudson Bay Eskimos). It is only in recent years, however, that the company has strongly encouraged the hunting of musk oxen, and although there is no record of the sale of any in the London Statement, 1853 and 1877, yet we now know that a number of pelts were occasionally, if not annually, traded at Forts Churchill and Anderson, at least subsequent to 1860, and that they must have sold there or in Montreal (the British company's market for buffalo robes), as the statement of the northern department fur-returns for outfit 1865, printed herewith (p. 756), shows that the districts of Mackenzie River and York, Hudson Bay, collected 25 and 66 musk-ox skins, respectively, in that year. During the last thirty years, the Indians and Eskimos have devoted more attention than before to the hunting of this valuable animal. In 1902, 271 skins and in 1903, 246 skins were exposed for sale, and the average for the past twenty years probably ranged between 200 and 250 pelts. The greater portion of those secured by the company are purchased in London and reshipped to, and used in Canada and the United States, chiefly as sleigh and cutter winter robes. In his Explorations in the Far North, Dr. Frank Russell, of the Iowa State University, has given a very interesting account of his successful efforts in hunting the musk ox in the Fort Rae Indian country. His other experiences in the territories of Canada are well worthy of perusal, while his services to science reflect much credit on himself and his alma mater. Mr. Caspar Whitney's achievements in the pursuit of the musk ox, under the unfavorable conditions as narrated in his published volume, also deserve commendation.

WOODLAND BUFFALO.

Bison bison athabascæ. Rhoads.

This variety of the American bison was fairly numerous when I first went north to Mackenzie River in 1853, but it has since gradually diminished in numbers in the Athabasca district, and its utter extermination is now only a question of time, unless restrictive hunting rules are adopted without delay. When Thomas Simpson, the celebrated arctic explorer, traveled down the valley of the Clearwater River in January, 1837, traces of buffalo were quite abundant, but for the last forty years they have practically forsaken that quarter and have dwindled so greatly in number that only a few individuals are now to be met with in open spaces and patches of prairie in sections on the west side of the Athabasca River, between Fort McMurray and the Birch Mountain, as well as in similar tracts of country from Pointe a la Paix on the lower Peace to the plains of Salt River in latitude 60° north, which had from time immemorial been regularly frequented and occupied by hordes of bison. At the end of the eighteenth and in the earlier part of the nineteenth century, buffalo were abundant on the upper

Peace River, and many also roamed to the northwest as far as the Liard River. Even as late as 1864 a straggler was killed within 40 miles of the company's post of that name and another in 1866 about 25 miles from the same. Sir J. Richardson states that there were some bison in the Horn Mountain, southeast of Fort Simpson, in the beginning of the last century (1800), while some were also met with on the east side of the Athabasca, below and above Fort McMurray. During a residence of fifteen years (1870 to 1885) at Fort Chipewyan, Lake Athabasca, our native fort hunters never failed in winter to kill one or more bison for the use of the establishment, the meat of which was hauled thereto by the company's dogs and servants. Nearly all of them were shot on the north side of the lower Peace River. At that time, the Indians of Forts McMurray and Smith always secured a number in autumn and winter. Having seen the skins of numerous prairie buffalo many years ago, and those of several of the woodland variety, I think the only marked difference I noticed was that the outer hair of the latter is darker in color, and the inner is of a finer, thicker, and probably warmer texture than that of the former, while it is doubtful if the average "dressed beef" of either animal of the same age would materially differ in weight. In the winter of 1871-72, an Indian shot an albino example of the bison some 35 miles northwest of Fort McMurray. This skin was throughout of a faint yellowish white color. I have been repeatedly assured by Indians that the female very rarely has more than one calf at a birth. They have also said that, in winters of deep snow, wolves succeed in destroying some animals. They themselves have too often been guilty of unnecessary slaughter of bison under similar conditions, especially in former years. In the month of March, 1879, a small band of Chipewyan Indians discovered traces of a herd, consisting of twenty animals of various ages, near the Birch Mountain, and the snow being deep they did not suffer even one to escape. None of the flesh, however, was wasted; all of it was consumed by the party. The company never exported any Woodland bison skins for sale in London or Canada. Mr. P. Deschambeault remembers seeing in the early fifties of the last century two fine albino examples of the prairie buffalo in possession of Chief Factors John Rowand and James G. Stewart, both of which had been secured on the plains of the upper Saskatchewan River.

CARNIVORA

CANADA LYNX.

Lynx canadensis Kerr.

This is one of the principal periodic fur-bearing animals which regularly increase and decrease in numbers about every decade. The experience of observers, largely corroborated by the company's London

sales, is pretty much as follows: The catch of lynxes for each of (say) three seasons when they are least numerous, or rather comparatively scarce, fell sometimes as low as 4,000 or 5,000 skins as the entire output for the immense extent of territory covered by the Hudson's Bay Company's business operations. The fourth year would double these quantities, the fifth often more than doubled the fourth, the sixth doubled the fifth, while the seventh almost invariably witnessed the maximum trade of skins. The eighth would still be good, while the ninth and tenth would each exhibit a startling decline in the returns, which in quantity would closely correspond with the sixth and fifth years, respectively, in each decade. Indeed, the regularity of these peculiar results in seasons of scarcity and plenty is remarkably interesting.

The Canada lynx is very widely distributed over the "Great Mackenzie Basin." It feeds on eggs, ducks, partridges, mice, stranded fish, and occasionally on a land-captured beaver, young deer, or sheep, while rabbits, of course, form their staple article of diet. It is chiefly taken in snares; some are trapped, and others are followed up with dogs, treed, and shot. The flesh is white and tender, and is an important and much-relished native country product. The female is said to bring forth from two to five, and not unfrequently as many as six, at a birth annually in June and July, the period of gestation being about three months. The young are about the size of a puppy, with the eyes partly open, but are very helpless for several days. They are suckled for about two months.

For the twenty-five years from 1853 to 1877, inclusive, the company sold in London a total of 507,450 skins of the Canada lynx, or an average of 20,298 a year. During that period, the minimum sale was 4,448 in 1863, and the maximum year was 1868, with 76,556 skins. The number entered in their catalogue in 1902 is 5,701, and in 1903, 9,031.

WHITE WOLF.

Canis albus (Sabine).

GRAY AND BLACK WOLF.

Canis griseus (Sabine).

The white is the most abundant variety of wolf in the far north; next comes the gray, and the black is the rarest. These wolves yearly succeed in killing as prey quite a large number of reindeer and not a few moose. On one occasion, while traveling upon the ice between Forts Liard and Nelson, in the Mackenzie River District, we came across a big patch of hard-packed snow on the Liard River where a large buck moose had evidently been surrounded and no doubt overpowered, after a most gallant fight for life, by perhaps a score of fero-

cious and cowardly wolves. A few well-picked bones and the skull were the only relics left. At a short distance, however, we perceived a full-grown gray wolf, which was at once shot. It had one of its hind legs shattered by a kick from the moose, which so disabled it that it could scarcely crawl. Had its companions not been fully gorged they would doubtless have fallen upon and eaten it too.

Although the old saying "mad as a March wolf" may not apply generally, yet there are seasons when many of them undoubtedly suffer from distemper similar to that which some years attacks Indian and Eskimo dogs, and are then more or less dangerous. In the month of March, 1868, large numbers of northern wolves were thus affected, and several Indians and one or two servants of the company were attacked and narrowly escaped being bitten, while it was currently reported that an elderly native woman had been killed about that time in the forest at a distance of several miles from Fort Rae, Great Slave Lake. Instances have also occurred where they have carried off dogs from the vicinity of the posts, and also from the winter night encampments of northern travelers.

In some seasons, the woodland wolf is more abundant than usual at certain points throughout the north. It is naturally more numerous in sections where reindeer abound. It breeds once a year—the female has from three to five, and occasionally as many as six at a birth. The eyes of the young are closed, and they are as helpless as dog pups for some days after they are born. The male is believed to assist his mate in rearing the offspring. Copulation of the sexes takes place during the months of February and March.

Wolves of this kind have been observed and some captured on many of the large islands to the north of the American arctic coast. Doctor Armstrong noticed a number on Baring Island and elsewhere, while Sir James Clark Ross states that considerable numbers of them collected on the narrow portion of the Isthmus of Boothia Felix in order to intercept the reindeer on their annual spring migrations. He also mentions that a single wolf will go among any number of Eskimo dogs and carry off one from among them without the others attempting an attack. General Greely's party obtained six examples at or near their winter quarters at Fort Conger, in Lady Franklin Bay, and he gives latitude $82^{\circ} 50'$ as the northern limit of this animal which is there indigenous. Sir Edward Parry records its presence on Melville and the other North Georgian Islands.

In the sketch of North Western America (1868), Archbishop Taché, of St. Boniface, Manitoba, recounts a remarkable instance of persevering fortitude exhibited by a large dark wolf caught in a steel trap at Isle à la Crosse many years ago. A month afterwards, it was killed near Green Lake, 90 miles distant, with the trap and connecting wood block still attached to one of its hind legs. It had evidently dragged

both around in the snow for many a mile, during a period of intense cold, and it was therefore not surprising that he was a "walking skeleton" when finally secured.

From the statement 1853-1877, inclusive, the company sold in London as many as 171,770 wolf skins, or an average of nearly 6,871 a year. I think more than half of them must have belonged to the smaller variety (*Canis latrans*) of the prairies and British Columbia. The three best sales were in 1855, with 15,419 (the maximum), 12,659 in 1859, and 12,616 in 1866; the three lowest, 2,802 in 1872, 2,083 in 1876, and 1,865 (the minimum) in 1877. In 1902, they sold 1,340, and in 1903, 1,790 skins. From 1858 to 1884, Athabasca District contributed 2,419 skins of the woodland (black, grey, and white) wolf to the London sales. For the outfits 1885 to 1889, it made a further addition of 339 skins. Between 1863 and 1884, inclusive, the district of Mackenzie River supplied a total of 1,880 skins of this animal. Its quota in 1889 was only 49 skins. From 1862 to 1887, Fort Resolution, Great Slave Lake, gave 193, and in 1884, 10 skins. The posts of the upper Peace River, with its lake stations transferred from Edmonton, sent in 48 woodland wolves in 1889.

The Eskimos use the fur of the different varieties of wolves for trimming the hood and other portions of their deerskin capotes or tunics.

COYOTE.

Canis latrans Say.

This smaller prairie wolf is not found much to the north of the northern branch of the Saskatchewan River; but on the west side of the Rocky Mountains it is, in some seasons, fairly numerous as far as latitude 55° north. Mr. Moberly, an intelligent and experienced observer, writes:

The prairie wolf seldom attacks any large animal except when led on by a woodland example. After a time, however, he will learn to kill domestic sheep without any assistance. They generally live on mice, gophers, musquash, berries, and carion. I think the wood wolf inhabiting the plains country is much smaller than the kind found farther north, and also lighter in color, and may possibly be a cross between both species. It is more cowardly than the true woodland wolf.

He further states that the male renders no assistance whatever to the female in providing food for the young, which number from three to five, and occasionally six. Indians have known of instances where both kinds of wolves and some of their dogs have mated, and they have always found that the resulting offspring were not only prolific, but also better and stronger as beasts of burden. Parry records an instance—the first authentic one known to him—where a setter dog had intercourse with a female wolf (*Canis griseus*). It was soon afterwards killed by a male of the same species.

New Caledonia District, British Columbia, usually sends in from 40 to 120 wolf skins annually, fully three-fourths of which belong to *Canis latrans*.

ESKIMO DOG.

Canis familiaris borealis (Desmarest).

The Eskimos make use of this indispensable animal for traveling during the winter season, and in summer it renders much assistance in tracking their boats (umiaks) upstream, on the Mackenzie, Peel, Anderson, and other arctic rivers. These boats are manned by women, and are always steered by an elderly man. When tracking on the beach, the woman is attached to the cord hauling line next to the bow of the umiak, then follow at intervals, similarly harnessed thereto, from four to six dogs, who with their leader go forward or halt at the call of their driver mistress. Nearly all of the hauling dogs used by the company at Fort Anderson were obtained from the Eskimos.

Early in the month of February, 1864, a very virulent and fatal form of distemper broke out among the post and native dogs, and, in a short time, it carried off about three-fourths of their number; but as there was still much work to be done in the way of transport of outfit and returns between the Anderson and Fort Good Hope, besides the hauling of fresh venison from the camp of the fort hunter for the spring and summer use of the establishment, we had to be constantly on the lookout to purchase as many dogs as could be spared by visiting Indians and Eskimos, to replace our heavy weekly losses. The distemper did not much abate until May, when it ceased almost as suddenly as it had appeared; but during the three and one-half months of its prevalence, the company lost no less than sixty-five sleigh dogs at Fort Anderson, while the total native losses must have been very considerable. It was remarked at the time that bloodless fights between healthy and affected animals resulted in no injury to the former, but when the fight was hard and bloody the disease was thereby communicated and the bitten dog soon fell a victim to it. Comparatively few ever recovered. Most of the attacked animals became very quarrelsome and some quite ferocious, while a few fled and died quietly in the neighboring woods, or after traveling a distance of from 5 to 15 miles. In course of a residence of over thirty years in the districts of Mackenzie River and Athabasca, I have known distemper to occur on different occasions at several trading posts in both, and always with fatal results to the dogs, but this Anderson epidemic was, I think, one of the very worst ever experienced in the far north. I find that Sir George Nares, when on his polar expedition of 1875-76, long after the foregoing was written, lost quite a number of his Eskimo dogs by distemper in his winter quarters in latitude 82° north. He writes that the "first observed symptoms thereof in an animal

was his falling to the ground in a fit, soon followed by a rushing about in a frantic manner as if wholly deprived of all sense of feeling. On some occasions one would rush into the water and get drowned. At other times a few would wander away from the ship and be seen no more. Sometimes their sufferings would terminate in death. Several appeared to suffer so very much that they were shot to relieve the poor things from their pain." Markham also remarks "that nearly all arctic expeditions have experienced the same kind of disease and mortality among their dogs, and for which there has hitherto been no remedy. Hydrophobia is unknown among the Eskimo or Indian dogs, as no one bitten by a diseased animal has ever suffered permanent injury therefrom."

Most of the true breed of Eskimo dog are more or less wolfish in appearance, while others facially resemble the common fox. Many of them are very playful and affectionate, but some others are bad tempered, sulky, and vicious in disposition. McClintock mentions one or two notable characteristics. "Chummie," the favorite dog in Commander Hobson's Eskimo team, while on the *Fox* in her celebrated pack-ice drift, disappeared and was supposed to be lost; but "after an absence of six days he returned decidedly hungry, although he could not have been without food all the time, and evinced great delight at getting back. He devoted his first attention to a hearty meal, then rubbed himself up against his own particular associates, after which he sought out and attacked the weakest of his enemies, and, soothed by their angry howlings, lay down and coiled himself up for a long sleep."

Like domestic and Indian dogs, the female of the species under review reproduces at various seasons, but as a rule most frequently during the warmer months of the year. The litter of pups seldom exceeds five in number, sometimes less and occasionally more, and there is no apparent difference in other relative dog characteristics. The full-grown female, however, is generally smaller in size than the male.

Arctic explorers and other voyagers of experience have written much and spoken highly of the capacity, the fortitude, and the endurance of the North American hauling dog. After half a century's residence in northwestern Canada the writer of these notes would be able to fill many pages with dog lore, but he has no desire to thus tax the patience of those who may peruse them. At the same time he thinks that a few readers might possibly take a little interest in certain traits, as well as in the performances of a small and rather short-legged dog of Eskimo breed, born tailless, which formed one of the train or team of a Hudson Bay sled of dogs conducted by himself on a winter journey of fully 2,000 miles, from Fort Simpson on the Mackenzie to Oak Point near the southern end of Lake Manitoba. We left the former point on November 30, 1869, and reached the latter place on Febru-

ary 22, 1870. We accompanied the old Hudson Bay winter packet, due to leave Fort Simpson annually on December 1, Fort Chipewyan January 2, Isle à la Crosse January 20, and Carlton House, Saskatchewan, early in February; but by rapid traveling the party managed to arrive at Chipewyan nine or ten days ahead of time. After a rest of several days we started with my own and another team of fresh dogs carrying our baggage and provisions. No time was lost on the march; in fact, we got over the ground between the different company's posts at a very rapid gait, and always had fresh baggage, men, and dogs, while the packet was dispatched independently on the usual dates from Fort Chipewyan, post to post, to Carlton. By this means I was enabled to give frequent rests, exclusive of Sundays, to my own team and personal servant, and also spend about a month in the aggregate with friends and acquaintances on the way. We never delayed the packet; on the contrary, when we finally overtook its bearers, our fourth and their seventh day out from Carlton, the united party made better progress, and but for the first Red River rebellion of Louis Riel it would have arrived at Fort Garry, if not earlier, certainly not later, than the usual date. When we reached the company's post at Touchwood Hills, there were orders for the packet to report at Fort Pelly instead of proceeding by the direct route by way of Fort Ellice. This necessitated the adoption of a much longer and more tedious course by way of Forts Qu'appelle and Pelly, Shoal Lake, Waterhen River, Manitoba House, Oak Point, and White Horse Plains to Fort Garry, which was reached on February 25, 1870. Having long lost the brief itinerary of this journey I can not at this late date give details, but I firmly believe that the time actually consumed in traveling was less than seven out of the twelve weeks spent thereon (except at the last we always rested on Sundays), and for that time we averaged more than 40 miles a day, a record probably never before or since attained by the same dogs on a trip of equal extent. Four of the five haulers were of Eskimo breed, and they were engaged thereon from start to finish. A spare dog who lingered behind our second day out from Fort Simpson was killed by a band of wolves not far from our night encampment. Another of the team, which suffered severely from sore paws, was replaced at Chipewyan. With the exception of one or two of the last of the many trade posts between Fort Simpson and Oak Point, the team invariably arrived at a rattling fast pace. It was the custom in those days, as it still is in some parts of the great interior, for winter voyagers to stop for a short time within a few miles of a post in order to make themselves presentable to the inmates. The dogs were also dressed with worsted or silk-fringed tapis of fine cloth, richly beaded or embroidered, and banded with brass or silver-plated round bells. Ribbon-adorned iron branched stands of small open bells screwed on top of their harness collars,

having three or four of a larger size stitched to the lower part thereof, made a fine display, while the jingling of the bells emitted sounds of a musical and agreeable nature. From previous experience, the dogs knew that they were approaching a haven of food, plenty, and temporary rest, and once started, they lost no time in cantering over the intervening distance. In course of upward of forty years' personal knowledge and experience of hauling dogs of various breeds in arctic America, British Columbia, and the Northwest Territories, the already-alluded-to smallest dog in my own team, *Keskayoo* (Cree for tailless dog), was, *for his size*, the very best all-round hauler I ever met, drove, or heard of in the country. The very nearest approach to him in endurance and other good qualities was *Cert-rolant*, so highly and justly commended by Colonel (now General) Sir William F. Butler, K. C. B., in his *Wild North Land*. During the winter of 1872-73, we traveled together from Carlton House to Fort Chipewyan, and I had, therefore, ample opportunities of witnessing the admirable qualities of that fine animal.

The mother of *Keskayoo* was barely a month old when I bought her from an elderly Eskimo woman at Fort Anderson, where she eventually developed into a small, but compactly built, creature. Her first litter of pups consisted of three males (one died of distemper months afterwards) and one female, who subsequently became the mother of the unfortunate dog eaten up by wolves on December 1, 1869. (The two survivors made the long winter journey.) On this occasion the mother appeared to suffer agonizing pain in endeavoring to bring forth her first-born pup, but the administration of a dessert-spoon full of tincture of lavender acted like a charm. The relief given was immediate, and all four pups were born without delay.^a Her next confinement, seven months later, was apparently easy. There was but one male (*Keskayoo*) and two females.

A more devoted and affectionate family of dogs I never knew. In corroboration of this view I would mention a few traits: The last litter was brought forth in a wooden kennel within the fort stockades, during the season when Indians and Eskimos were frequent visitors, and some of their hungry dogs would have no hesitation in devouring any stray puppies; but for months after their birth one or more of the first litter kept guard with the mother in protecting the young puppies from this or any other danger. In fact, they were never left alone during a period of several weeks, but were always carefully watched. I can not remember any instances of quarreling among themselves. On the contrary, they never failed to stand by each other when attacked by strange dogs or when they themselves became aggressive.

^a I may here remark that I have personally known several cases in which this medical preparation greatly aided both human and canine mothers under similar circumstances.

At times, long after he became a hauler, *Keskayoo* seemed to delight in beginning a fight with other dogs. He was himself a living embodiment of daring, energy, and pluck, quite capable of coping successfully with many of a much larger size, knowing, as he did, that his brothers would rally to his assistance in the event of his tackling a more powerful antagonist, or in a general scrimmage. It was sometimes amusing to watch *Keskayoo* while being fed, both at Fort Simpson and at the various posts on the above-described journey. A big "bully" among visiting teams at the former (the fort dogs let him severely alone) or the "cock of the walk" at some one of the latter, judging him by his small size, would brazenly come along and attempt to rob him of his fish or meat, but almost in a twinkling of the eye the assailant would be sprawling on his back, severely bitten, retiring afterwards quite crestfallen, with his tail between his legs. The unexpected suddenness and strength of the attack seemed to completely disconcert the would-be robber. It was seldom, indeed, that a second attempt of this kind was made at the same place.

Previous to the abandonment of Fort Anderson, early in July, 1866, it frequently surprised me to witness the joyful greeting which took place between the mother and surviving offspring of both litters when they met after days or weeks of necessary separation. Indeed, they were constantly together whenever possible. Two of the later litter died of distemper and the old mother herself perished a couple of months after giving birth to four beautiful pups in her third and final confinement. Unfortunately, they were accidentally frozen to death in December, 1865.

Keskayoo was exceedingly quick and active in moments of attack or defense, while the protection afforded by his own remarkably long-haired and densely thick fur skin-covering rendered it almost impossible for any dog's teeth to meet in any vulnerable portion of his body. Poor *Keskayoo* died during my first brief visit to the old land in 1870. He was a wonderful little animal; he never seemed tired or weary; he was always ready and willing to follow the track beater, or the sled ahead of him; for three-fourths of the entire journey he acted as foregoer or leader of his own team. Years of association with these dogs naturally brings about an almost human regard or affection for them, and their death frequently seems a personal loss.

Although much more of an interesting nature might be related of this and other northern hauling dogs, the writer will conclude with a few remarks regarding the appearance of what, from the perceptible symptoms, must have been English dog distemper. In summer it was usual to send the Fort Simpson dogs to Big Island at the west end of Great Slave Lake, where fish are more or less abundant all the year round, to be well fed until the autumn. Early in October, 1869, my team of dogs arrived with the first fish boat from that point; but, to my deep

regret, I found that two of the best had been ill for over a week and utterly unable to walk or even stand up, and they had to be carried from the river to a picketed yard adjoining the officers' residence. Their hinder parts seemed to be entirely paralyzed. As they were strong and tried animals, I naturally desired to have them with me on my then contemplated trip to Fort Garry (now Winnipeg City). Knowing that there were several boxes of Holloway's celebrated pills among the post's store of medicines, I determined to test their vaunted virtues by ascertaining if they were equally efficient in canine, as they claimed to be in human ills. I began by giving them each a dose of five pills, night and morning. After one week's course I reduced the number to three, and at the end of the fortnight there was a perceptible improvement, which became more marked and assuring as the weeks went by. About the middle of November I began to harness and drive them slowly around. The two convalescents staggered a great deal, and this continued for some days; but a short time prior to our departure, on November 30, 1869, they had nearly recovered and were able, with the others, to make daily runs of several miles at a very good pace. The improvement continued, and I think they became almost as strong and untiring as ever. Some of the fort residents all along asserted that they could not recover fully or stand the long journey; but I, who had much previous knowledge of their staying powers, was of a different opinion, and the result proved that I was right.

HARE INDIAN DOG.

Canis lagopus (Richardson).

This animal is more or less typical of the indigenous Indian dog of the far north of Canada. It is not so stout or strong as the Eskimo dog, but many individuals can endure a vast amount of hardship in the shape of heavy sleigh and packing work with but little to eat. It is even more necessary for the Indians, especially the so-called "caribou eaters" (as the latter move and travel about in winter following the reindeer) than is the case with their brethren who subsist chiefly on fish, rabbits, beaver, and moose. The Eskimos, with the exception of roving traders from the west and Alaskan coast of North America, do not make any very extensive excursions during the winter season. In birth, traits, habits, and liability to epidemics there are no material differences between it and *Canis familiaris borealis*, nor, for that matter, with the rather mongrel breed or introduced varieties of hauling dogs used by the company, missionaries, and the "freemen" of the interior. I might also mention that I have heard of one or two instances of English distemper having appeared among inland dogs.

RED FOX—CROSS FOX—SILVER FOX—BLACK FOX.

Vulpes sps.

The natives consider the foregoing as belonging to one and the same species (the common red fox), an opinion generally, but not universally, accepted by naturalists and collectors; and while it is just probable that the different varieties have occasionally been found among the litter of a red fox mother, yet I have for a long time been of the opinion that there must have been originally two distinct and well-defined species of North American fox—the pure red and the pure black (*Vulpes fulva* et *V. nigra*)—and, as a matter of fact, there still exist many of the former and some of the latter throughout the entire region under review. I also firmly believe that sexual intercourse between a male and female red fox invariably results in the production of only red foxes. I am equally satisfied that similar results always follow cohabitation between a male and female black fox. In course of many years' trading of fox skins, I have observed perhaps every possible degree of variation between the practically perfect, typical red fox and the same description of the black form. These varieties between the two are easily accounted for, as a consequence of the natural commerce which exists among the sexes during the annual seasons of copulation.

Since writing the above, I have come across Chief Trader Bernard R. Ross's Popular Treatise on the Fur-Bearing Animals of the Mackenzie River District.^a I will now quote from page 16 thereof the views held by him and therein stated, and with which I fully agree, in this connection:

In treating on the different varieties of foxes I have spoken of, it is extremely difficult to mark the line where one ends and the other commences. During my residence in these regions I have seen every shade of colour among them, from a bright flame tint to a perfectly black pelt, always excepting the tip of the tail, which in all cases is white. Even the judgment of an experienced fur trader is sometimes at fault to decide, in bartering, to which of the three varieties a skin should belong, as they bear different prices. Still, notwithstanding this, I consider these colours to have been produced by intermixture of breed. The different varieties, being in my opinion, quite as distinct as those of the human race. And I do not think that any of the progeny of two pairs of red foxes would be either black or cross. In cohabiting the male foxes accompany the females in bands of from 3 to 10, much in the manner of domestic dogs. At Dunvegan on Peace River, I have repeatedly observed this. The males fight violently for the possession of the females, many are maimed and some killed. A number of males thus in all likelihood cohabit with the same female, which gives rise to the varieties of colour in a litter.

Instances are reported as having occurred in which all the varieties were taken in one den, but of this I am rather doubtful. It is very difficult to tell the future colour of cub foxes, the red appear to be cross, and the cross to be silver, which may have caused an error, though I write under correction. I have seen many Indians even

^a Canadian Naturalist and Geologist, VI, 1861.

mistaken in this. They have brought me live cub foxes for silver, which on growing up proved to be cross. My own theory is that the silver fox is the offspring of two silver parents, the cross, of a silver and red, the red, of 1 x 0 reds, and the different shades being caused by fresh inter-breeds. Thus two negroes will have neither white nor mulatto children, nor will two whites have black or mulatto offspring. I do not know whether I have explained my ideas on the subject clearly or not. They are the result of my experience on a subject to which I have given no small attention. I have often robbed fox dens, and have also bred the animals, and the summing up of this part of my subject may be thus made—like colours reproduce like, black and red being origins, the cross is the fruit of intermixture between these shades. I kept a pair of cross foxes in confinement at Slave Lake; their offspring were *all cross*. I had only one litter when the bitch died. Foxes are very shy animals, and difficult to tame, indeed when old they appear to pine away in confinement, when young they are playful, but at all times rather snappish. They are far from sociable and generally burrow alone, although it is not uncommon for the members of one family to live together.

The above views, I deferentially opine, are perhaps as reasonably probable as that of the eminent Prof. Spencer F. Baird in respect to the origin of the American red fox, which he and others thought might be the lineal descendant of individuals of the European red fox introduced many years ago. The fact of their present abundance and extent of distribution being no barrier to the reception of the idea. It is rather remarkable, however, that the supposed varieties—cross, red, silver, and black—should, in Europe as well as in America, be confined to the northern portions of both continents. Neither can the gray fox of the United States, entirely unknown in northwestern Canada, be considered as their progenitor, as these varieties are conspicuous by their absence wherever that species of fox predominates. I now regret that during my long residence in the Indian country I neglected to have the theory of fox origin practically tested, but I hope the matter will eventually receive due attention.

Doctor Armstrong mentions that one of the crew of the *Investigator* saw a "black fox" on the shores of Baring Land (island), near Cape Colquhoun, early in September, 1851. Again on November 11 of the same year, one of the men observed another black fox on the ice, about a mile from the ship, then wintering in Mercy Bay, latitude 76° north. He further says that there was no previous record of the appearance of this animal so far north, but that its existence there could not be questioned. It may be asked in vain, Were these foxes but one and the same individual twice seen, or were they indigenous, or a pair of recent stragglers from the continent? With the exception of the blue and white foxes (*Vulpes lagopus* and *Vulpes fuliginosa*), of which all arctic explorers make frequent mention, I believe these are the only recorded instances of any species of fox having been observed on the lands situated to the north of the American Continent.

In course of fifteen years' residence at Fort Chipewyan, Lake Athabasca, the Indians brought me five litters of young foxes. Until they



FORT CHIPEWYAN, ATHABASCA LAKE.

were several months old, it was very difficult to determine the variety to which they belonged. The red first declared itself. Two of the litters (five and seven cubs, respectively) were all red, as was their mother; two were all cross (mothers were cross), five cubs each; and the fifth consisted of one red, one very fine, and three fair cross foxes, from a red female. I would remark that they were successively kept within a small, closely stockaded yard adjoining the office building at Fort Chipewyan. At first, each litter was placed in a small wooden kennel, and they were very lively and frolicsome. They soon came to know those who fed and visited them, but they were timid, snappy, and retiring with strangers. As they grew up and the season advanced, they took to burrowing in the ground under the office, but they never tried to get away. So soon, however, as winter approached and snow began to fall, they became very restive and made frequent attempts to escape by tunneling under the building and the outer stockades. In time, one or more of each litter were successful in their efforts, and soon after fell victims to outside trappers at no great distance from the establishment. This, of course, led us to dispatch the others for the benefit of their attendant. Dogs also managed to kill two or three of the total number.

The female brings forth annually in spring from three to as many as six and seven at a birth. They are born blind, and are very helpless for some days. Gestation occupies about two months, and the young are said to leave their natal home when several months old. They are generally most numerous around the shores of lakes and among marshy tracts in the vicinity of the larger rivers.

It is a well-known fact that foxes greatly fluctuate in numbers—for some years in succession they are very abundant, and then for a longer or shorter period they become comparatively scarce. Chief Trader Bernard R. Ross (1848 and 1862) estimated that the proportion of the various colored foxes traded by the company in the Mackenzie River District for ten years of his time would be about six-fifteenths red, seven-fifteenths cross, and two-fifteenths silver and black. From 1853 to 1877, inclusive, the Hudson Bay sales in London totalled 59,650 cross, 260,775 red, and 20,100 silver and black. For thirteen of the twenty-five years, the cross-fox sales fell below the average of 2,386 a year, say from 1853 to 1856, 1862 to 1866, and 1872 to 1875, and these minus quantities ranged from 1,172 in 1854 to 2,315 in 1873. The other twelve years varied between the lowest, 2,455 for 1876, and the highest, 5,174 skins in 1869. If we observe the same rule in dealing with red foxes, we have only eight years which exceeded the average of 10,431 skins. These are 1857 with 10,526, 1859 with 11,488, 1860 with 11,031, 1867 with 20,824, 1868 with 26,822, 1869 with 20,267, 1870 with 13,058, and 1877 with 11,233. Four more years were not far under the mark: 1858 with 9,707, 1861 with 8,897, 1875, with

8,973, and 1876 with 9,838. The remaining sales of the period ranged between the lowest, 3,175, in 1854, and 8,760 in 1865. The average number of silver and black foxes for the twenty-five years was 804. Eleven of these years exceeded the average, namely: 1853 with 847; 1857, 1,072; 1858, 1,060; 1859, 1,164; 1860, 1,177; 1861, 1,066; 1868, 1,253; 1869, 1,490 (the maximum); 1870, 914, and 1877 with 971 skins. The year 1875 fell short by 9 skins. From the minimum sale of 390 in 1854, we have had a series of four years between that figure and 696 in 1871. In 1902 the company sold 1,447 cross, 5,912 red, and 280 silver foxes; and in March, 1903, 1,970 cross, 6,200 red, and 491 silver and black foxes. It may also be of interest to mention that for fifteen (1863-1877) of the often-referred-to twenty-five-year London sales statement, Mackenzie River District supplied 6,072 cross, 8,034 red, and 1,699 silver and black foxes. For twenty years thereof (1858-1877), Athabasca District contributed 4,652 cross, 6,582 red, and 1,450 black and silver foxes. All these facts go to establish the claim that these foxes should be classified among the "periodical" fur-bearing animals of North America. In the Indian country tributary to Fort Anderson, the several varieties of foxes were fairly abundant in good years, and this was more so on the lower portion of the river and along the arctic coast between Herschel Island and Cape Bathurst.

KIT FOX.

Vulpes velox hebes Merriam.

This fox does not inhabit the territories to the north of the upper Saskatchewan River, nor is it found in New Caledonia, British Columbia. I never obtained an example during two years' residence at Fort St. James, Stuart Lake. I was equally unsuccessful at Cumberland House, lower Saskatchewan, where I was stationed from 1889 to 1894. It used to be abundant in the great prairies of the West from that river to the international boundary. Naturalists may be interested in the fact that the total number of skins of this animal sold by the Hudson's Bay Company in London from 1853 to 1877, inclusive, was 117,025. The best year was 1858, with 10,004, and the poorest, 1864, with 2,410. There are no foxes of this kind entered in their fur catalogues for 1902 and 1903.

WHITE FOX.

Vulpes lagopus inuitus Merriam.

The white fox is numerous most winter seasons on the arctic coast inhabited by the Eskimos of the Anderson and Mackenzie rivers, and no doubt more or less so on other American polar shores, and, when this is the case, numbers are also met with in the timbered regions to the south and on the larger ice-covered lakes and rivers.

Even northern sections of the country hunted by Indians belonging to some of the company's trade posts of Cumberland and English River districts have, at times, succeeded in trapping a few examples. In 1876, Cumberland House had 5; in 1873, Moose Lake secured 3; in 1885, the Pas had 2 and Pelican Narrows 16; in 1886, Rapid River caught 2, and Lac du Brochât post traded 785 skins, nearly all from its northern inland Eskimos; in the winter of 1890, Portage La Loche secured an example. A few white foxes have also been trapped on the south shore of Great Slave Lake, but at Fort Resolution the natives of Fond du Lac and the northeastern tract, who resort thereto, seldom fail to bring in some skins every season. The catch there from 1862 to and including outfit 1877 averaged 42 a year. Fort Rae, at the northern end of the same great inland sea, also turns out a few skins most years. In 1877, it had only two examples, but the average for 1880 to 1882 was 23 for the three outfits. Many years ago an individual of the species was shot a considerable distance up the Peace River. Sir John Richardson states that early in the nineteenth century two white foxes were seen near Carlton House, on the Saskatchewan River.

We hardly ever saw a live white fox on our many summer and winter trips in the arctic regions of Canada. Neither have I observed among several thousand prime winter skins of this animal one that was not almost if not wholly pure white, while the blue variety always appeared distinct in color. McClintock, who had many opportunities for observation, writes that both white and blue foxes are found in all arctic lands, and that they are beautiful animals, full of tricks and impudence. In September, 1853, he "captured a litter of three cubs of a dark grayish color—fierce little fellows with most restless eyes and pliant weasel-shaped bodies. Not unfrequently foxes would venture on board the arctic ships in winter and be caught even in traps set for them on deck. When irritated they gave a short, suppressed bark, and they sometimes uttered a strange cry resembling that of a hawk, goose, or gull." At Port Kennedy, where he passed the winter of 1858–59, McClintock secured two polar bears, nineteen white foxes, nine hares, eight reindeer, and eighteen seals; several ermines and lemmings were also caught. Sir J. Clark Ross, who passed several years in Victoria Harbor, Boothia, latitude 70° north and longitude 91° west, states that the foxes breed there early in June, and have from six to eight young at a birth. On one occasion, several weeks later in the season, he captured six little ones in a sand burrow close to the ship's wintering position. White foxes were numerous in that quarter, and upward of fifty were trapped. Sir George Nares observed a "mottled" fox in latitude 82° north. Doctor Armstrong also refers to the presence of *V. lagopus* at Mercy Bay and Prince of

Wales Strait, where some fifty specimens were taken during their long stay.

Other expeditions in the polar regions have met with many white and a few blue foxes. General Greely obtained but twelve of the former, and he gives latitude $83^{\circ} 24'$ north as the most northerly range of this animal, which is there indigenous. He says that the white fox of the Grinnell Land section is much more wary than that of a few degrees of latitude farther south, and therefore very difficult to approach for a shot, while all but one example rejected many poisoned baits set for them. Mr. Peterson, the well known Eskimo interpreter of several expeditions, asserted that this species made caches of food for winter consumption. Captain Lockwood found several fox lairs. In one hidden rock nook he found fifty dead lemmings, in others (sand and earth covered) there were from twenty to thirty lemmings, while in a hollow he discovered a cache containing part of a polar hare and the wings of a young brent goose and the usual lemming. Some lairs appeared to be occupied from year to year. McClintock writes that in March, 1859, at Port Kennedy, he shot a couple of white foxes that came playing around the dogs, and, conscious of their superior speed, were very impudent, snapping at the dogs' tails, and passing almost under their noses. The captain intended both foxes for the mess table, but the dogs anticipated him in respect to one. The flesh of the other proved insipid, but decidedly better to the taste than the tinned meat.

When comparatively scarce, or rather less numerous than usual, as sometimes happens in their native habitat, it is a rare thing to meet with any foxes in the interior. It is said that a litter consists generally of three and four, seldom five, and when born the young are blind and helpless, but they soon acquire sight and gradually increasing strength, and they also become active and very playful. The adult fox is seemingly stupid and is easily captured by both Indians and Eskimos. It lives on mice, lemmings, birds, and carrion.

During the period of twenty-five years, 1853 to 1877, the company sold in London a total of 124,100 skins, or an average of 4,964 a year. The three best sales were in 1856, 1864, and 1869, which amounted to 10,311, 12,242, and 12,088, respectively, and the three lowest were in 1855, with 1,897, 1859, with 1,577, and 1871, with 1,805 skins. In 1902, 8,487 skins, and in 1903, 10,717 skins were sold at the same place.

If the Hudson Bay and Canadian arctic blue fox be a variety of *Vulpes lagopus*, which I certainly doubt, the stone-blue fox of the Pribilof Islands and other Alaskan islands, even in originally introduced cases, is surely entitled to specific rank. Blue foxes occur very sparingly on the northern, Hudson Bay, and Labrador coasts. We secured very few skins thereof at Fort Anderson. It is, indeed, a very rare inland visitor. Mr. Bernard R. Ross writes that up to the

close of outfit 1861 he had known of only two instances, and in both the examples were secured on the verge of the "Barren Grounds," situated near the eastern end of Great Slave Lake. The very next season, however, after his departure from Fort Resolution in 1862, the same Indian tribe killed one summer and three prime winter skins thereof. Outfit 1872 also records another winter example. From 1853 to 1877 the company had in all but 1,100 blue foxes for sale in London, an average of only 44 a year. The three best year's sales were in 1864, with 82 skins, 1869, with 124 skins, and 1873 with 90 skins. The smallest sales were 3 skins in 1860, and 13 skins in 1868, while the years 1857, 1859, and 1871 yielded but 15 skins each. Chief Factor Robert Campbell, one of my predecessors in charge of Athabasca District, received three skins in 1859 and two more in 1862 from the most northerly Indians who resort to Fond du Lac, Athabasca. During my fourteen years' management, we obtained 15 skins from the same "Barren Ground" quarter. It may also be mentioned that between 1862 and 1883 the district of Mackenzie River traded 140 skins, nearly all from the Eskimos resorting to Fort McPherson. Fort Good Hope gave an occasional skin as the result of Indian trade with the Eskimos of the Anderson after the Fort was abandoned in 1866. In 1886 Fort McPherson turned out three and Good Hope three also. In 1887 the former gave eleven skins and the latter one. In 1889 Fort McPherson had one, Rampart House one, and Lac du Brochêt, Reindeer Lake, traded seven skins from its northern inland Eskimos. Sir James C. Ross obtained three examples of this fox on the shores of Boothia. Parry secured several, and although Armstrong and Kellett of the *Resolute*, each have about fifty foxes in their game lists, which have been considered as white, one or more of them may have been blue. Nares, as above stated, observed a "mottled" specimen, while Greeley writes that eighteen of the twenty secured by him on Grinnell Land were free from any sign or mark of white, red, or yellow, and that all of them were smaller in size and lighter in weight than the twelve of his captured dozen of *V. lagopus*. McClintock, however, shot a prime blue fox while drifting in the *For* with the pack ice in the winter of 1857-58, although 130 geographical miles from the nearest land. It was very fat, having probably lived on dovekies. McClintock often observed tracks of the arctic fox following the polar bear for discarded seal scraps.

WOLVERINE—CARCAJOU.

Gulo luscus (Linnaeus).

This comparatively powerful and very destructive animal is to be met with all over the northern continent to and along the shores of the Polar Ocean. Although Doctor Armstrong does not have the wolverine

in his list of observed mammals, yet several arctic explorers have either seen the animal or traces thereof in very high latitudes. A skull, minus the lower jaw, was picked up on Melville Island, latitude 75° north. Sir James Ross found it abundant on Boothia Felix. He received skins of two adult and two young wolverines from the Eskimos. Another was captured in winter on shipboard, having fearlessly climbed over the banked snow in search of food which from his thin condition he much needed.

When in prime condition, the fur of the wolverine is highly prized by the Eskimos, more so than that of the wolf, for the purpose of trimming the hood and other portions of their outer reindeer-skin clothing. Several skulls of adults and two skins and skulls of young animals were secured at Fort Anderson and duly forwarded to the Smithsonian Institution at Washington.

The Company of Adventurers of England trading in Hudson's Bay, received and sold in London 32,975 skins of this species from 1853 to 1877. The returns were lowest in the years 1857 (923), 1866 (909), and 1867 (768). The three best sales of skins in the statement were in 1871 (1,848), 1873 (2,095), and 1874 (1,763). The sales for 1902 and 1903 amounted to only 635 and 695 skins, respectively. It is estimated that the old northern districts of Athabasca and Mackenzie River furnished fully two-fifths of the foregoing quantities.

As the habits and depredations of this "uncivilized robber" have already been fully and frequently recounted by naturalists, I need not add to its well-known record. I may, however, say that copulation of the sexes takes place in the months of March and April, and that the female brings forth the offspring about sixty days later. They are from one to three, four, and occasionally as many as five in number. They are said to be born blind, and are very frail for some time, but soon acquire more strength. Suckling is supposed to last for two or three months. A discarded beaver-lodge, a vacant bear-hole, or any other suitable depression in the ground serves as a nest. The male is supposed to render some assistance in rearing the young.

Fortunately for the natives, who suffer so much from his depredations, the carcajou is not very abundant anywhere, although doubtless too much so everywhere, for the reason that even one will, in course of a single season, do an incredible amount of damage. They are first-class experts in persistently demolishing very extensive lines of deadfall, marten, and other traps, as well as in hiding, eating, or otherwise injuring the animals found in them. They treat rabbits and lynx caught in snares in a similar manner. They will further break up well-built caches of meat, fish, and sundries. The wolverine is undoubtedly entitled to first place among the destructive animals of North America, and is also the most detested of them all.

FISHER.

Mustela pennanti Erxleben.

It is very seldom, indeed, that an example of this species is found beyond latitude 62° north in the Mackenzie River region, or any other part of America. I never knew of any being taken at Fort Simpson, while the very few skins received there were trapped by Indians in the forest country some distance to the south; but on the upper Peace River, and in the country farther south, east, and west, on both sides of the Rocky Mountains, the fisher is fairly numerous.

The male and female are said to come together annually in the months of February, March, or April, according to locality, and the offspring vary between one and five in number. They are born blind and helpless, but soon acquire sight and strength. They nest in a hole in the ground. Some say the male assists in rearing the young, but others deny the truth of this assertion. They subsist on rabbits, fish, and mice. Mr. Colin Thomson states that for winter consumption they provide quantities of "hips" in advance.

It may be mentioned that from 1863 to 1883 Mackenzie River district traded the skins of 331 fishers. More than three-fourths were obtained from Indians resorting to Fort Resolution, who hunt to the south of Great Slave Lake, as well as along the Slave River, the balance coming from natives belonging to Forts Simpson, Providence, Liard, Halkett (abandoned), and Nelson. The last post (latitude 59° north) had one skin for each of the outfits 1886, 1887, and 1889. Fort Providence had one and Fort Simpson six examples in 1889. For the period 1858 to 1884, Athabasca district turned out 5,138 fishers. The average trade for the five succeeding outfits (1885 to 1889) would be about 100 skins less a year, after making due allowance for the gain by the Resolution transfer and the loss of the four upper Peace River posts (constituted a new district in 1878). The contribution of the latter for 1889 was 122. That of the stations added thereto (taken from Edmonton) was as follows: White Fish Lake gave 33, Sturgeon Lake 20, Trout Lake 20, and Lesser Slave Lake 61 skins for the same year. English River district, by its posts at Isle à la Crosse, Portage La Loche, and Green Lake supplied 63, 18, and 48 skins, respectively, for 1889, and 22, 19, and 31 skins, respectively, in 1890. The district of New Caledonia, British Columbia, gave an average of about 300 skins a year for the years 1885 to 1889, while Fort St. James, Stuart Lake, and Frazer Lake always headed the list in nearly equal quantities; the other posts, except Babine, made up the balance with much smaller quotas. Then we have Cumberland district, with a total of 195 skins for 1888 and 216 in 1889; but with the exception that Cumberland House had 51 and 42 skins for the two years, respectively, I can not give details as to where the rest of the lots came from. Mr. P.

Deschambeault never saw a single fisher during his fifteen years in charge of Lac du Brochêt, Reindeer Lake.

While the annual London sales for the first twenty years, 1853 to 1872, ranged between the minimum, 4,605 for 1866, and the maximum, 7,959 in 1870, the sales of the last five, 1873 to 1877, only amounted to 3,639, 3,539, 3,558, 3,263, and 3,338 skins, respectively. The three best sales of the series were 7,197 for 1860, 7,477 in 1869, and 7,959 in 1870; and the three lowest were 1875 with 3,558, 1876 with 3,263, and 1877 with 3,338, as above mentioned. In 1902, the company sold 3,679, and in 1903, 3,223 skins, making a grand total of 144,107 for the twenty-seven years in question. Judging from the northern department returns for outfit 1865 (sold in London in 1867) I think that about two-fifths or more of the fishers appearing in the company's annual fur catalogue must be obtained from the western, southern, and Montreal departments of the Hudson Bay service.

MARTEN.

Mustela americana abieticola Preble.

This is probably the most constant of the "periodic" fur-bearing animals, whose presence in considerable numbers is very largely dependent upon a greater abundance of hares or rabbits, though mice also form an important item of marten diet. The remarks made under *Lynx* in this regard have a similar, but somewhat modified, application to this American representative of the Russian sable. In years of plenty the marten is very numerous throughout the entire northern forest region; but it is not uniformly so at the same time in every section of country all over the immense territories covered by the Hudson's Bay Company's trading operations. When it is abundant or scarce, say in the northern and western departments, it will generally be found that there is an important and corresponding increase or decrease in the southern and Montreal departments. The natives maintain that lynxes and martens migrate from the north and west to the east and south, and that when they have attained their height in numbers for several seasons, the great bulk (no section is ever totally devoid of martens) of those who escape capture resume the return march until the next period of protracted migration. It must be admitted that many old fur traders have come to entertain similar views from their own personal experience and observation. Of course there are post, district, and departmental fluctuations in annual results, caused by local epidemics among the hunters and other relative reasons, but, on the whole, I think the aforesaid twenty-five years' London sales statement adds strength to the migration theory, and is otherwise of some interest. If it were possible, however, to obtain from the London executive a complete abstract of all the furs and peltries annually disposed of by the Hudson's Bay Company, since the union with

the Northwest Company of Montreal in 1821, to 1903, a period of eighty-two years, this opinion would probably receive further confirmation.

In this connection, native allegation in respect to a corresponding increase and decrease in the birth rate of the marten and other "periodic" and migratory species may be worthy of a little attention from interested naturalists. The following comparison of the yearly London sales of this pelt may help any such in enabling them to arrive at a better understanding of the subject, and for this purpose, sales exceeding 100,000 will be classified as "good" and under that figure as "lean" years. To begin with, we have two of the latter—1853 with a sale of 73,050 skins, and 1854 with 91,882. I have reason to believe that the three preceding years (1852, 1851, and 1850) would come under the same grouping, while the five previous (1849, 1848, 1847, 1846, and 1845) should be considered as "good" years. Then we have six of the same description, two of which, 1856 with 179,736, and 1857 with 171,022 skins, were probably the best ever realized by the Hudson's Bay Company from incorporation in 1670 to the present time. The other four "good" years' sales were 137,009 skins in 1855, 138,535 in 1858, 139,124 in 1859, and 102,235 in 1860. These six years were succeeded by only three "lean" years (1861 with 74,738, 1862 with 80,484, and 1863 with 79,979), which were immediately followed by five "good" years—1864 with 112,396, 1865 with 124,830, 1866 with 142,970, 1867 with 126,616, and 1868 with 106,784 skins. Then came no less than eight successive "lean" years' sales (1869 to 1877), having but one bright break, in 1875, when the sale amounted to 131,170 skins. I think the best since the transfer of the country to Canada was in 1870. The total for each of the eight years last mentioned was 81,706, 52,308, 55,453, 60,455, 66,841, 66,750, 83,439, and 81,174, respectively. The aggregate total sales of martens for the twenty-five years amounted to no less than 2,590,691 skins. In 1902, the company sold 56,491, and in 1903, 78,629 marten skins in London.

The two best and most successful months for the trapping of this valuable animal are November and March, while comparatively few are taken during December, January, February, and April. Severely cold weather is not a favorable factor in hunting, for the reason that at such times martens do not roam as much as on other occasions. The sexes begin to copulate in February, and the process is continued to the end of March, according to situation or other circumstances. For some time afterwards, martens are more easily captured than at almost any other period of the season. The young are blind and helpless when born, but shortly acquire sight and strength. They make their nests in hollow trees, or under fallen timber, and in holes in the ground.

Comparatively few skins were obtained from the country north of

Fort Anderson, but in the forest region to the south martens were fairly abundant in some years. The writer has seen several albino examples, and also a considerable number of bright yellow and dark orange colored martens in his time, particularly while stationed in the districts of Mackenzie River and Athabasca. In the month of February, 1890, Albert Flett, then chief of the Cumberland House band of free Indians, brought me a large male marten somewhat different from any that I had previously met with or specially noticed. After it was properly skinned and prepared, it was forwarded to the Smithsonian Institution at Washington. I think the chief told me that he had trapped it in the Pas Mountain, some 60 or 70 miles to the southward of Cumberland House. He also informed me that he had seen several similar animals captured in the same quarter. It is now described under *Mustela americana albigicola*, subsp. nov., Hudson Bay Marten, in *North American Fauna*, No. 22, 1902, by that zealous naturalist, Mr. Edward A. Preble of the U. S. Biological Survey.

WEASEL—ERMINE.

Putorius arcticus Merriam, *P. cicognanii* (Bonaparte), and *P. cicognanii richardsonii* (Bonaparte).

I believe the weasel extends to the north of Fort Anderson, where several specimens were obtained from the natives in course of our five years' residence from 1861 to 1866. The Eskimos of the lower Mackenzie and Anderson rivers use the skin of the weasel very largely in their conjuring and other religious exercises. It may be here mentioned that ermines are not particularly abundant within the Arctic Circle, although there, as elsewhere throughout the wooded country, they are more numerous some seasons than others. Doctor Armstrong refers to the presence of one of these species on Baring Land. Sir James Ross says they are fairly abundant at Boothia Felix, where they feed mainly on lemmings. Sir George Nares observed many ermines where he wintered in 1875-76. General Greely also secured eight examples on Grinnell Land, and gives latitude $82^{\circ} 36'$ north as about their highest range in that polar quarter.

Quite a large number of specimens of these animals were obtained at Fort Anderson from the Eskimos, as well as from the Indians, and a few were captured in the stores and in the vicinity of the place. They range to the shores of the American coast. Ross, Nares, Greely, and Doctor Armstrong refer to these species in their respective arctic exploring volumes. The female gives birth to her young, from four to eight, and sometimes as many as nine and ten, in May and June, annually. They are said to be blind and very helpless when born, and so continue for some time afterwards. Although ermines no doubt destroy some food themselves, yet when one manages to get inside a Hudson Bay inland store, it soon makes a clean sweep of field or other

mice, which frequently do a considerable amount of damage by devouring and concealing meat and other eatables, and in cutting up cloth and goods. A domestic cat seldom evades death from native dogs. In May, 1885, a skin of this species was forwarded from Fort Chipewyan, Athabasca, to Dr. Robert Bell, of Ottawa; and in July, 1889, three trade specimens from Babine Lake, British Columbia, were sent to Washington. It is fairly abundant in New Caledonia District. The Hudson's Bay Company now annually trades and exports to England many thousand ermine skins; but for several decades previous to 1887 the prices obtained for them were not remunerative, and their hunting was not therefore encouraged. Jubilee and coronation functions have, however, brought them once more to the front, to the advantage of the hunter, the trader, and the seller. From 1853 to 1877, inclusive, the company's average London sales of ermines amounted to 2,476 skins a year. The five best years were 1873 with 4,012, 1874 with 4,447, 1875 with 4,732, 1876 with 6,360, and 1877 with 5,338; and the five lowest, 1858 with 1,034, 1859 with 809, 1862 with 912, 1863 with 1,178, and 1864 with 899. As against all this, the sale of 1902 reached 16,374, and that of 1903, 33,883 skins.

MINK.

Lutreola vison lucustris Preble.

The mink is one of the company's staple pelts, and although it is but very slightly dependent on the American hare for food, yet it somehow seems to periodically augment and decrease in numbers much in the same way, not perhaps in as precise, but still in a remarkably interesting manner. If we adopt a minimum of 50,000 and under as a "lean" unit, and sales above that figure as "good," as was done in the case of the marten sales, we may better understand this. The sales of the years 1853 and 1854 were 25,152 and 42,375 skins, respectively. There is reason to believe that the sales of the three previous years were below the average. Then came five "good" years in succession, 1855 with 50,839, 1856 with 61,581, 1857 with 61,951, 1858 with 76,231, and 1859 with 62,264 skins. Next we have four "lean" sales, 1860 with 44,730, 1861 with 31,094, 1862 with 49,452, and 1863 with 43,961 skins. These were followed by six "good" years—1864 to 1869—with 61,727, 60,334, 51,404, 58,451, 73,575, and 74,343 skins, respectively. Once more we have four "lean" sales, 1870 with 27,708, 1871 with 31,985, 1872 with 39,266, and 1873 with 44,740 skins. The year 1858, already mentioned, with 76,231, 1876 with 79,214 (maximum), and 1877 with 79,060 skins were the three largest years' sales for the period under review. The total output of minks, exclusive of some 15,000 skins sold in Montreal and St. Paul, was 1,365,360.

This animal is to be found along the Anderson and other arctic rivers to the coast, and also throughout the Dominion of Canada from the Atlantic to the Pacific. The sexes come together in March and April, and the female brings forth in due time five or six blind and helpless little ones. I have also been assured that where the food conditions are very good, instances of as many as eight, ten, and even twelve have been observed. In this connection I would remark that Indians in different parts of this vast country have asserted that when the several periodical fur-bearing animals are at a minimum stage the births are few, but that these augment annually in number during the seasons of increase. This rather remarkable, but probable circumstance, applies particularly to musquash, martens, minks, ermines, foxes, and skunks. A number of hunters have also said to me that they have sometimes noticed this peculiarity in the case of beaver. Albinos are rare, but the writer has seen a few in the course of his forty years' service.

SKUNK.

Mephitis hudsonica (Richardson).

I believe that a few straggling individuals have been met with as far north as the Upper Peace, the lower Athabasca, and the Upper Slave rivers, but I never heard of any having been discovered in the Mackenzie River District, or beyond Great Slave Lake. Chief Trader B. R. Ross, however, found the bones and part of the skin of a skunk at a short distance from the south shore of that great inland sea. As already indicated, this is one of the herein-designated "periodic" species. The statement of sales in London rather corroborates this view, although perhaps not in as exact a manner as under martens and minks. First, we have 1,619 skins for 1853, then seven successive "good" years, ranging from the lowest (4,474 in 1854) to the highest (11,320 in 1856) for the entire period of twenty-five years. These were followed by seven "lean" years (1861 to 1867) with from 1,617 for 1865 to 3,758 in 1861. After that three more "good" years, 6,208 in 1868, 6,679 in 1869, and 9,606 in 1870. Then we finish the list with seven poor seasons from 1871 to 1877, varying between 1,322 in 1874 and 3,928 in 1877. I regret that I am unable to furnish details of the later sales, except for the years 1888, 1902, and 1903, and they consisted of 16,322, 5,682 and 5,206 skins, respectively. There is no record of the trade of even one example of this fur-bearing animal in the Athabasca or Peace River Districts for over thirty years subsequent to 1858, nor, I believe, previously; but from its former Edmonton posts to the south some skins have since been obtained. In 1889, Lesser Slave Lake gave 62, Sturgeon Lake 3, Trout Lake 2, and Whitfish Lake 20 skins; English River District, to the southeast of Athabasca, turned out 461 skins in 1889 and 207 in 1890, most of which

were purchased from Indians resorting to Isle à la Crosse and Green Lake. Portage La Loche had but 11 and 14 skins, respectively, for those outfits. At Fort St. James, Stuart Lake, British Columbia, the company traded 6 skunks in 1887, 23 in 1888, and 61 in 1889. Frazer Lake post contributed about one-half of the number. It is said that the sexes come together in the months of February and March, and that the female produces from four to seven young, which for a time are blind and rather weak and helpless. In May, 1885, I sent the skins of two young skunks, secured shortly before by an Indian near Fort Chipewyan, Lake Athabasca, and captured south of the place, to Dr. Robert Bell, of the Canada geological survey at Ottawa.

BADGER.

Taxidea taxus (Schreber).

Sir John Richardson gives latitude 55° north as the limit of this animal's northern range. It used to be fairly abundant in the prairie regions, but as these are settled, it is gradually diminishing in numbers. If it ever extended as far as the Peace River it must have been many years ago, as not a single example has been traded by the company in that quarter since 1858 (I have no earlier data), but elsewhere to the south, they collected a total of 39,579 skins between 1853 and 1877. The best three years were 1870 with 2,445, 1873 with 2,705, and 1876 with 2,274 skins, and the three lowest, 1854 with 886, 1857 with 871, and 1867 with only 597 skins. In 1902 and 1903, respectively, the London sales amounted to 1,141 and 824 skins.

The female badger has from three to five at a birth, and they are said to be like most mammals, born blind and helpless. Mr. Donald Gunn of the Red River Settlement, Manitoba, was misinformed when he wrote that the Indian name for badger was *Weenusk*. This, I believe, is the native (Cree) name for *Arctomys monax* and *Mistunusk* for the badger. In 1889, Isle à la Crosse and Green Lake each traded one badger skin, and the latter one also in 1890.

RACCOON.

Procyon lotor (Linnaeus).

According to the company's twenty-five years' statement (1853-1877), they sold a total of 99,179 raccoon skins in the London market. During that period, there were only six years when the annual sales exceeded the average (3,967), and they varied between 4,011 in 1872 and 11,678 in 1867, with 21,321 for 1868 as the maximum. The remaining nineteen years ranged from the minimum (1,042) in 1877 to 3,883 in 1863, the maximum. Strange to say, there is not one raccoon entered in the Dominion senatorial report of the Lampson's and Hudson's Bay Company's fur catalogues for the year 1887. In the latter's catalogue for 1902, however, we have 1,967 and in that for 1903, 1,024 skins. I understand

that this species is, now at least, very rare in the northwest of Canada, while it is probable that most of the foregoing returns were obtained in other sections of the country, to the west, south, and eastward. In the second volume of Audubon and Bachman's *Quadrupeds of North America*, Audubon has given us a full and interesting account of the habits of this species. As to its northern and western distribution, he quotes from Sir John Richardson and others. The former supposed that the raccoon extended farther north on the shores of the Pacific than it does on the eastern side of the Rocky Mountains. Dixon and Pastlock confirm this, as they obtained skins from the natives of Cook River in latitude 60° north. Richardson further states that the company procured about 100 skins from the southern parts of the fur districts, as far north as the Red River in latitude 50° north. It is said to hibernate for a portion if not most of the winter. The young, usually from four to six in number, are quite small at their birth, which generally takes place in May, though varying with the range.

LAND OTTER.

Lutra canadensis (Schreber).

The Canada otter is but very sparingly present on the lower Anderson, nor could it be truthfully stated that it was very abundant in the far north; still, it is generally met with in every locality adapted to its requirements. There are seasons also when, for natural reasons beyond our knowledge, it is more markedly numerous in certain sections of the country than is usually the case; but the very extraordinary statements made by Bell^a that there were imported into England 713,115 skins of the American otter in 1830, 494,067 in 1831, and 222,493 in 1832, must be enormously exaggerated. As only 23,889 is the total given for 1833, the other figures must surely be grossly incorrect. The company's aggregate sales for the twenty-five years previous to 1878 only amount to 318,140, or an average of about 12,723 skins a year. In March, 1888, they sold 11,588; in the same month of 1902, 8,675, and 10,273 in 1903. The three best years of said period were 1864 with 15,443, 1866 with 18,380, and 1867 with 15,271, and the three lowest 1853 with 8,991, 1874 with 9,010, and 1877 with 9,926 skins. In fifteen years (1863-1877) of the aforesaid twenty-five, Mackenzie River district supplied 1,984, and the Athabasca district in twenty years (1858-1877) supplied 4,861 skins toward the above grand total. The Mackenzie River contribution by Fort Resolution, Great Slave Lake, was 427 for the same period.

By widely separated hunters, this animal is said to mate during the months of March, April, and May. The offspring are from three to

^a British Quadrupeds, 1837, p. 136.

five in number. One informant says they are born with their eyes wide open, but all of the others assert the contrary. Richardson mentions that the female has one litter of from one to three annually in April; but Indians in the far north (in New Caledonia, British Columbia, on the Peace and Saskatchewan Rivers) vary in their several accounts. Traces of its "sliding," or travels from one stream to another over the winter snow, have been frequently observed, and as a result some—not all—of those seen are shot or run down and bludgeoned. I never, however, heard of any instance in keeping with Godman's "otter-sport" sliding amusement.

GRAY SEA-OTTER.

Lutra lutris (Linnaeus).

During the oft-mentioned twenty-five years, the Hudson's Bay Company obtained from the natives of Alaska and northern British Columbia, a total of 4,100 skins of this formerly abundant but now rare and very valuable sea-otter. The three best years were 1855, which produced 338 skins; 1856, 319 skins, and 1858, 343 skins, and the three poor seasons were 1862 with 84, 1870 with 90, and 1872 with only 66 pelts. Their London catalogue sales for 1902 and 1903 seen by me do not contain a single entry of this animal.

GRIZZLY BEAR.

Ursus horribilis Ord.

There are no bears of this species in the Anderson River country, nor on the adjoining arctic coast, but I believe they are sometimes encountered, and their skins secured, in other parts of the northern districts on the west side of the valley of the Mackenzie to the Rocky Mountains. The female, it is said, brings forth one or two, and occasionally as many as three at a birth, every third year. The first few years are always spent by them in their mother's company, after which they are expected to provide food, a mate, and hibernating quarters for themselves. Comparatively few skins of this bear are received from the Indians, and they, together with most of those of *U. richardsoni*, figure under *gray* in the company's accounts. As all of the four kinds—black, brown, gray, and white—are grouped together in the fur sales statement, it is impossible to give the quantities of each for the period in question; but the catalogues for 1902 and 1903 furnish details, while their totals are only 143 skins below the average collections for the twenty-five years. The year 1902 yielded 161, and 1903, 246 skins of the "gray" bear. For fifteen of the twenty-five years (1863 to 1877) Mackenzie River District furnished 665 "gray" bears. There are no available data for a similar period for Athabasca; but in 1886, 1887, and 1889, 68 more skins were obtained from that district, while the

posts on Upper Peace River gave 35 skins of the bears designated above. The adjoining district of New Caledonia, on the west side of the Rockies, also contributed a certain number of skins of this species to each year's London sales. Mr. Moberly, who spent several years in British Columbia, says that he was credibly informed that many years ago grizzly bears were occasionally met with in the Pas Mountain of Cumberland District and amid the Touchwood Hills of Manitoba; but such is not the case now. He further says:

There seems to me to be a different species in the Rocky Mountains. They are much larger than any other grizzly bears seen on either side. Their color is lighter and they have a whitish mane, and are much more ferocious, but not so numerous as the others. Indian hunters readily attack the latter; few, however, will willingly venture on a contest with the Mountain King unless the chances are very favorable.

It is also on record that the grizzly bear, as well as the black bear, were not uncommon to the eastward and in certain other wooded sections of the Red River Valley at the end of the eighteenth and beginning of the nineteenth century.

RICHARDSON'S BARREN GROUND BEAR.

Ursus richardsoni Swainson.

This bear is not uncommon in the Barren Grounds of the Anderson region nor on the polar shores of Franklin Bay, where, apart from a few exported skins, we annually secured during our five years' sojourn at Fort Anderson one or two examples, with the skulls and skeletons suitable for museum purposes. The characteristic disposition of this rather formidable animal may be fairly judged from the following experience: In the end of July, 1862, an Indian brought in the skin, skull, and leg-bones of a medium-sized male, which he shot in the Barren Grounds northeast of the post. He informed us that as soon as the bear perceived him, it at once advanced toward him, and when at a few yards distance, he fired at and killed it. On the 8th of the same month an Eskimo secured a large male on the east side of the lower Anderson, about 50 miles north of the fort. The first shot struck and broke one of its hind legs, which greatly angered the bear, which fiercely pursued its assailant, but a second ball fortunately laid it low in rather close proximity to his person. Again, on June 30, 1863, a member of our Indian collecting party succeeded in killing a very large male on the shores of Franklin Bay. From a high and narrow shelving ridge near the head of a deep ravine, he observed the bear at some distance below, and in order to attract its attention he began to whistle and throw stones at it, much to master bruin's disgust, and it immediately started to ascend to where the Indian from his chosen vantage ground stood prepared to receive it. After permitting it to approach within 10 or 12 feet he fired at and mortally

wounded it, but to make his work sure he at once rushed out and drove his knife to the hilt in the bear's heart. The skin and complete skeleton of this animal were secured and forwarded the following summer to the Smithsonian Institution at Washington. About three weeks previous to our arrival at Franklin Bay, in the end of June, 1864, two Eskimo hunters observed a brown bear at some distance, and being, for them, well armed, they went forward to meet it and did their best to annoy it by uttering very loud and shrill cries. They made a stop, however, at a driftwood stand, shortly before constructed by them for the purpose of shooting therefrom at passing ducks, geese, and swans, and there prepared for action. One of them carried a Hudson Bay single-barreled flintlock gun, and the other had a spear formed by firmly attaching a long knife of Eskimo make to the end of a somewhat slender pole about 6 feet in length. When the bear had closely approached them, it was shot and severely wounded, which, of course, made it perfectly furious, and it came on so very quickly that there was no time to reload the gun; but, just as it was about to spring at and close with the man who had fired the gun at it, the other man struck fiercely at it with his spear, and both soon dispatched it with their knives. This animal will not only hug, and if possible crush, any unfortunate falling into its clutches, but will also bite with its sharp teeth and scratch viciously with its powerful claws, as Indians and Eskimos have occasionally experienced to their cost. In the spring of 1864, one of the leading men of the Mackenzie River Eskimos, while hauling with a comrade on the slopes of a high sea-bank, was suddenly attacked, knocked over, and severely bitten by a large male, which would doubtless have speedily finished him had not his companion, who happened to be near by, killed the bear by a quick and well-directed knife thrust. Another instance of biting occurred in the Anderson Barren Grounds in the month of August in the same year. An Indian on a hauling tour observed an animal of this species, which he determined to shoot, reposing on the top of a knoll, but to make sure of his quarry he crawled quite close to it, and on pulling the trigger of his gun it unfortunately snapped; but the sound awoke the bear, and before the Indian could draw his knife he was thrown down, and the bear at once began to bite him in the shoulders, arms, and legs; but for some unknown reason it soon desisted and disappeared, leaving the poor fellow in a badly mutilated and helpless condition. Luckily for him, his friends missed him and a search was made which resulted in his discovery; he was then taken on to his own lodge, not far away, where he was carefully attended to, but, some three or four months elapsed before he recovered sufficiently to be able to hunt again, and he will no doubt carry the scars of the wounds of his very narrow escape from death, to his grave. The wonder is that he was not killed outright.

Early in the morning of July 15, 1865, as I was in my tent, emptying some birds' eggs gathered the previous day a few miles east of the Wilmot Horton River, I noticed the countenance of an Indian assistant who was at the door suddenly change color and exhibit much fear. I asked him what ailed him, and he muttered "*sass*," which is the Chipewyan general term for bear. I got up immediately, looked out, and with much delight saw what under the peculiarly hazy mirage of the hour, when objects not far away appear comparatively gigantic, one enormous and two young Barren Ground bears coming direct for our camp. I at once roused up our best shots and made ready to accord them a very warm reception; but just as they were about arriving within range of our muzzle-loaders (there were no breech-loading rifles in those days) the mother bear perceived the tent, as well as our crouched party, which, under the stated atmospheric conditions must have struck her with fearful astonishment, as she instantly got up on her haunches, a proceeding followed by her offspring (over two years old). After having a fairly good look at us, they all bolted, while apparently not one of the dozen balls fired at them went home, as they scampered away at a rapid pace, and so escaped. On the succeeding evening, another large animal was seen, and he appeared to be making right for our encampment; but, although he was allowed to approach quite close, we failed to secure him. On another occasion, several of our Indian hunters observed a bear busily engaged in feeding on the carcass of a reindeer, which had probably died from the effects of a bullet-wound received a short time previously on the arctic coast, near Langton Harbor, Franklin Bay. As soon as they were noticed, he got up on his hind legs and after a square look at them decided to retire, and succeeded in doing so scathless. From all that has been narrated herein, I think it will be readily admitted that the male, at least, of *Ursus richardsoni* is a bold and courageous animal, and when wounded is quite as brave and formidable an antagonist on his own grounds as his cousin, the true mountain grizzly, is in his territory. The female is doubtless less aggressive, except when defending her young. Nearly all these referred to were males. The Indians say that the females give birth to one or two cubs every third year, and that they keep company and hibernate for two seasons in the same shelter-hole or cave with their mother. The pouches of the bears secured by us were mostly full of various edible roots, and one or two contained some partially-digested venison. Exclusive of a comparatively small number of skins shipped as trade returns of the post, I may mention that the Smithsonian Institution received several examples of the full-grown and some spring cubs of the male and female of the Barren Ground bear. A. G. Dallas, esq., then resident governor-in-chief of the Hudson's Bay Company, had a fine large mountable specimen sent to him by request. A similar sample was also forwarded

to Prince Jerome Napoleon, of France. The former was secured in 1863 and the latter in 1864. I have not noticed any reference to the presence of this or the other species of bear on the lands to the north of the American coast visited by the different arctic expeditions.

BLACK BEAR.

Ursus americanus Pallas.

The black bear is not at all common within the arctic portion of the Anderson River, but in the forest country to the south on both sides of the valley it is fairly abundant. It subsists chiefly on roots, edible grasses, berries, and green leaves, and on stranded fish and dead animals when procurable. The Indians occasionally kill a male or female bear which has neglected to hibernate, or for some unknown reason has left its winter shelter, and such examples are generally in a more or less impoverished condition, while many of the "winterers" are still quite fat as late as March and April when shot or speared in their holes or caves. In the far north, one and two, but rarely three, young are produced at a birth; but the Indians of New Caledonia district, British Columbia, have assured me that two, three, and four at a time are events there of rather frequent occurrence, and that even as many as five have been occasionally observed. This difference in prolificness may be owing to the fact that while roots and berries may be equally abundant in both sections of country, salmon are very abundant in their season and easily accessible in the western spawning rivers and streams, and there form the chief item of diet of the bears. The young usually hibernate two seasons with their mother, after which they are rather harshly repulsed by her and thereby made to understand that they must set up house and provide for themselves. This course would indicate that they breed only every third year, while some Athabaskan Indians thought they did so each alternate spring. In this connection I would mention that the Carrier Indians of Stuart Lake, British Columbia, have told me that it was an event of the utmost rarity (one such occurred in the spring of 1889) to kill a hibernating bear with unborn young. Even when attacked in their winter shelters, they will almost invariably manage to abort the young, if not already in existence, immediately on becoming aware of the near presence of men with deadly intentions. During the rutting season, the males of all bears are always more ferocious than on other ordinary occasions. They frequently fight together until one submits, nor will they hesitate to attack any man they may meet at such times. When bears quit their winter-quarters, they usually resort, morning and evening, to the nearest small stream and feed on the small fish. They also eat roots, etc., as already mentioned. When wounded, they are said to utter a cry and moan in pain much as most

men would do under similar circumstances. This is particularly the case with the black bear. They are taken in snares, shot, and captured in deadfall and powerful steel traps. The Indians themselves can not account satisfactorily for the recurring seasons of exceptional scarcity of bears in certain regularly-occupied tracts. If the bears perished by disease, or even starved to death—a very unusual occurrence—they think that they should sometimes come across their remains in their many hunting peregrinations, if only for the reason that relics of a badly wounded animal are almost invariably discovered sooner or later in the vicinity of the locality where it was shot. Migration, therefore, seems the most reasonable solution of the difficulty. Remarks as to food, habits, and distribution, but not numbers, made under this heading are equally applicable to *U. cinnameus*, the skins of which are usually described as *brown* in the company's lists.

For the reasons already given under *U. horribilis*, I am unable to show the quantities of each color sold in London for the period from 1853 to 1877, but with the aid of the following data a fairly correct estimate of the proportion of black and brown bears collected in the northern district, at least, may be formed, namely: From 1863 to 1883, Mackenzie River District furnished a total of 906 black and 571 brown, and for 1886, 1887, and 1889, 1,678 black and 183 brown skins. The posts of old Athabasca produced 712 black and 70 brown in outfit 1889. Then came the London catalogues for 1902, with 7,087 black and 161 brown, and 1903, with 6,444 black and 246 brown bears. In the twenty-five years' statement, all the bears are grouped together under one heading, and they aggregate a total of 200,042, or an average of nearly 8,002 a year. The bear returns for the two years 1902 and 1903 are only 143 skins below this average, while the competition in the fur trade during the last three decades has been far and away the greatest in its history since the coalition with the Northwest Company in 1821. For twenty-seven years, from 1858 to 1884, inclusive, Athabasca District's quota to the London sales was 13,997 assorted bears. This total would have been upward of 2,000 larger but for the transfer in 1878 of the posts of Battle River, Dunvegan, Hudson's Hope, and St. John, with other Edmonton fur-trade stations, to constitute the company's new district of Peace River, which, for outfit 1889, turned out 500 black, 67 brown, and 38 gray bears. For the five years 1885 to 1889, New Caledonia district, British Columbia, supplied 1,602 assorted bears, and in 1889, 333 black, 11 brown, and 21 gray, as against 412 black, 22 brown, and 20 gray shipped the year previous. I may mention in conclusion that the English River District, next on the southeast of Athabasca, traded 283 black and 64 brown in outfit 1889, and in 1890, 399 black, 120 brown, and 1 gray bear skins.

POLAR BEAR.

Thalarctos maritimus (Phipps).

With the exception of a few trade skins annually received from the Eskimos during our five years' residence at Fort Anderson, we secured but three assorted examples of this bear, which were forwarded to Washington. One of them, the best, was shot in Liverpool Bay, and the other two, I think, were killed near the outlet of the Wilmot Horton River in the Franklin Bay. The Eskimo who brought us the latter stated that he and a companion were watching for passing ducks and geese in a small sheltered, but open, stand, which they had built with blocks or slabs of hard frozen snow close to the shore, when they saw a large white bear coming from the sea in their direction. They permitted it to almost reach them before one of them fired at and wounded it very severely, while the other soon finished it with his spear. The second animal was killed later in the same spring (1865) in a similar manner.

The writer of these notes entered the service of the Hudson's Bay Company on June 25, 1852. We embarked in the company's sailing ship *Prince of Wales* (Capt. Daniel Herd) at Stromness, Orkney, on the 3d of July and reached York Factory, Hudson Bay, on the 15th day of August following. While retarded in the navigation of Hudson Strait by large fields of drifting ice, a full-grown polar bear was observed from the ship, and as the captain was desirous of procuring a suitable specimen, he ordered his chief mate, John Hackland, to lower and man one of the boats for this purpose. The company's surgeon (H. S. Reddome) with several of the cabin passengers, myself included, obtained permission to accompany him. As soon as bruin perceived the boat proceeding in his direction, instead of being scared, he boldly advanced to meet us, and we were therefore not long in coming to close quarters. A couple of shots were fired at him, one of which evidently struck home, as he immediately turned tail and set off at a rapid and much blood-marked pace over the ice. After a hot pursuit we gave up the chase, as it was impossible to follow him with the boat or on the moving masses of floating ice. We then returned to the ship greatly disappointed at the loss of such a fine animal. Next morning another bear was seen, but at a considerable distance; but we were more fortunate on a subsequent occasion, while we were similarly delayed by ice near the center of Hudson Bay. This attempt by the same boat party was crowned by the capture of a much larger polar bear than Captain Herd had ever observed in the course of the twenty voyages then made by him between London and York Factory. It was an old veteran, and had evidently participated in many a hard-fought battle for food and love, the proof marks of which were deep and many in number. The last great

fight for life was the culminating point of a career which surely entitled him to hold the position of the unquestioned championship of the white bears of Hudson Bay. The sailor in the crow's-nest was the first to perceive the bear at less than a mile's distance. He appeared to be engaged in a fierce combat with some large animal, which turned out to be the case. When we came up to him he only had had time to partake of a few mouthfuls of the warm flesh of an enormous seal (*Erignathus barbatus*) which had been killed by him after a terrible struggle, evidences of this being plainly visible. He looked as if he was very angry indeed at our unseasonable interruption of his well-earned dinner, and at the same time determined to stand by his hard-won prize. At first Mr. Hackland thought we might be able to secure him alive, by noosing him with a stout rope while in the water, but soon gave up the idea as too dangerous, and we then, some six or seven men with guns, fired repeatedly at the bear while on the ice and swimming in the sea, at very close quarters; but although many of the bullets went wide of the mark, the shooters being mostly youngsters of little experience, we afterwards ascertained that it had taken a number of penetrating ones to oblige him to crouch down and appear to die. After most of our party had landed on the same large block of ice, in order to take possession of their prey, one of them, with gun still loaded, noticed in time a rather sudden movement of the bear, which might have resulted disastrously had he not been promptly finished by a ball through his head. He had been mortally wounded, but he no doubt feigned death in order to avenge himself, and would probably have succeeded had he not been killed outright as stated. We towed his carcass to the ship, and it was at once hoisted on board and well skinned by expert Greenland whale-fishery men among the crew. He was very fat and heavy. Very soon after our return, a severe gale sprung up, which enabled us to leave the ice fields for good.

Except for 1902 and 1903, when 170 and 96 skins, respectively, were sold in London, I have no idea of the company's annual sales of this species. All the skins are obtained from natives of the arctic coast, Hudson Bay, Ungava, and Labrador. When the North Pole is discovered, as I expect it will be some day, I believe the white bear will be one of the very few mammals found there. I think every arctic exploring and Franklin search expedition refers to the presence of this animal in the polar seas of Greenland and the Dominion. The *Investigator* secured four large specimens in Prince of Wales Strait, and Doctor Armstrong calls Baring Island "the land of the Polar Bear." Sir Leopold McClintock observed several individuals when drifting with the *For* in the pack ice in 1858, at least 110 geographical miles from the nearest land. On the other hand, Doctor Armstrong thought the meeting of an example over one mile inland on Baring Island

an interesting and most unusual occurrence. Sir George Nares's party secured several specimens in 1875-76. General Greely obtained several. He writes that they were very rare in Smith Sound, north of Cape Sabine. Lieutenant Lockwood, however, saw a polar bear at Cape Benet on the Greenland coast in latitude $82^{\circ} 24'$ north, which is the most northerly American record. Sir Edward Parry, in 1827, observed one on the ice also in latitude $82^{\circ} 24'$ north, to the north of Spitzbergen Island. "On August 18, 1859, while almost becalmed off Cape Burney, a mother polar bear, with two interesting cubs about the size of very large dogs, swam off to the *Fox* and were all shot." McClintock says that the "veal" of the young appeared among the delicacies of their table, and that Christian had asked him for a portion of the old bear to carry home to his mother in Greenland, where the flesh is considered a real delicacy. He further says that he acquired the arctic acquisition of eating frozen bear's blubber in very thin slices on biscuit, and vastly preferred it to frozen pork. At the time of writing, however, he thought he could not even taste it, but the same privation and sense of starvation from *cold*, rather than *hunger*, which induced him to eat it *then*, would doubtless enable him again to partake thereof *very kindly*, if similarly "cooked by frost."

PINNIPEDIA.

WALRUS.

Odobæus rosmarus (Linnæus) and *O. obesus* (Illiger).

Fifty years ago, the walrus was numerous in the northern seas between Point Barrow and Cape Bathurst and to the eastward. On several of our overland bird and egg collecting expeditions from 1862 to 1865 we observed a few individuals basking in the sun on the pack, as well as on large blocks of tide-swayed ice at the southern end of Franklin Bay. The Anderson Eskimos frequently brought into the post for trade various articles made from the ivory tusks of the walrus. Their umiaks, or women's boats, are usually made by sewing the requisite number of hides together and placing them over a framework composed of drift timber. The skins are also cut up into stout thongs, which are highly valued, and the best procurable for dog-sled line lashings. Its flesh and oil are greatly prized by the Eskimos. After passing to the east of Point Barrow, Doctor Armstrong was "surprised by seeing numerous herds of walruses (*Trichechus rosmarus*) grouped together on the large detached masses of ice, drifted off from the main pack, apparently asleep or basking in the sunshine. The novelty of a sight so unexpected was gladly welcomed, and various and amusing were the opinions given by the men who had never seen them before as to what they could possibly be, while they gazed in mute wonder and amazement at the strange sight before them. They

did not exhibit any feeling of alarm as we approached; one or two could be seen dropping into the water, but it was not until we had got within a few yards of them that, as if by a preconcerted signal, they rolled or tumbled into the sea, and for a time became invisible. They appeared to live in perfect harmony, a lazy, listless air characterized the whole. I could not but admire the affection displayed by the dam for her young which were crawling on the maternal back as we approached; but the moment the mothers perceived the danger, they seized them under their arms and disappeared; nor did we see them again at the surface until there existed no cause for alarm. Greenland Arctic seamen consider the 'marine beef' of this animal excellent eating, an opinion concurred in by all medical men who have been engaged in polar explorations."

General Greely gives latitude 79° 40' north as the highest probable range of the walrus. It is indigenous in Hudson Bay and strait and also in many other portions of the northern ocean.

HARBOR SEAL.

Phoca vitulina Linnaeus.

This is probably the most generally distributed and abundant of all the northern species of hair seals. I believe it is also the most numerous in the coast seas of arctic America. The Anderson and Mackenzie River Eskimos kill a great many annually. It is a very valuable and useful animal for them; its skin is necessary for making boots and hunting canoes and other purposes. Its dark and rather unsightly flesh and extracted oil are among the chief and most esteemed articles in their yearly diet; the latter is also used in their stone lamps for light, heat, and cooking their food. We noticed some seals on the ice, basking in the sun, on each one of our four summer trips (1862 to 1865) to Franklin Bay. The Eskimos with us killed a few with the bows and arrows. Our Indian assistants did not seem to relish the rather disagreeable-looking flesh, but the Eskimos partook thereof with avidity. Doctor Armstrong, of the *Investigator*, observed many and secured several examples of this species in the waters of Baring Land. It has also been met with by other arctic explorers. Sir Leopold McClintock's party secured 17 examples of the smaller seals at Port Kennedy. During their eight months' drift in the pack ice, they killed 73 seals, 2 polar bears, 38 dovekies, and the blue fox already referred to. On March 2, 1858, they shot 4 fat seals and several dovekies; the largest seal weighed 170 pounds and the smallest 150 pounds. They were males of the species *P. hispida*. The flesh of this species was very disagreeable, a garlic-like taint so strongly permeating the whole animal that even Eskimos are nearly overpowered thereby, but the females are at all times free from feter. A week later two more seals were captured. The flesh being free

from taint the Eskimos had fried liver and steaks for breakfast, the latter preferred. They had been washed in two or three waters to get rid of the blubber. The flesh was very dark and very tender.

McClintock doubts if seals breed in the drifting pack, as they never saw any cubs during their stay in that risky position. *P. hispida* may also be known to the Eskimos of the northern coast of America. General Greely writes that it is indigenous at Grinnell Land, and that it was met with as high as latitude $82^{\circ} 58'$ north. *P. granlandica* is also present as far as latitude $81^{\circ} 30'$ north, but he considers it migratory. They secured a number of the several resident species, including 27 examples of *P. hispida*. Sir Edward Parry's highest latitude (attained in 1827) was $82^{\circ} 56'$ north. In a lane of open water in the ice he observed one of the last-mentioned species. This was until recently thought to be the most northerly position ever reached by seals. Mr. Preble noticed a number of skins of this species in the company's stores at Fort Churchill, Hudson Bay.

From Hudson Bay, Ungava, and Labrador, the company receive and sell in London annually thousands of hair-seal skins. From 1853 to 1877 the sales aggregated a total of 259,600. The three best years in the series were 1867 with 21,458, 1861 with 18,104, and 1863 with 16,933; and the three lowest, 1853 with 1,425, 1854 with 2,021, and 1855 with 2,842. After a long period of good results, the returns have fallen to only 3,061 skins for 1902, and 2,509 for 1903. There is reason to believe that other species of seals besides the harbor seal are embraced in the foregoing sales statement.

(Some reference to Fort Churchill may not prove out of place among these mammalian notes. Comparatively few of the Canadians of to-day are aware that "upon a rocky spit forming one side, and commanding a splendid harbor, stand the still well-preserved remains of a massive fortification, the most northerly one of British America, scarcely inferior as such even to old Louisburg and early Quebec, its site admirably chosen, its design and armament once perfect, and interesting still as a relic of a by-gone strife, and now only useful as a beacon for the harbor it had failed to protect." Some day again, however, in the not distant future, when the Hudson Bay route, now so much decried by many eastern and by a few western "unbelievers," shall have become an accomplished and successful navigable ocean waterway between Canada and Europe, the Imperial Government may consider it advisable to rebuild upon the ruins of the old, a new and impregnable "Fort Prince of Wales.")

BEARDED SEAL.

Erignathus barbatus (Erxleben).

Although we received no whole skins of this species at Fort Anderson, we had every reason to believe that it is an inhabitant of the northern ocean. It is common in Hudson Bay and Strait and along the Alaskan coast from Bristol Bay northward. Ross observed it in Boothia, and it has also been met with by other arctic explorers, including Nares, and Greely obtained several specimens. The latter gives latitude $81^{\circ} 46'$ north as the highest point where an example (8 feet $2\frac{1}{2}$ inches in length and weighing 640 pounds, gross) was secured. He considers it a summer visitor so far north. McClintock mentions that the Dane, Peterson, shot an example in Bellot Strait which weighed 500 pounds, and that its flesh was preferable to that of the smaller seals. The Eskimos who resorted to Fort Anderson made use of the parchment-dressed skins of this species for the canoes, and occasionally also for their women's boats, instead of that of the walrus. They heartily enjoy partaking of its flesh and oil, no matter how rank it may become by keeping. They can and do eat raw meat and fish; but during the summer season, as well as when living in their winter huts on the coast, they cook the former, and the latter also when fresh, much in the same way as do Indians and others. During our five years' sojourn at Fort Anderson we received large quantities of sun-dried reindeer tongues and venison, in excellent shape for consumption, from the river Eskimos.

FUR SEAL.

Callorhinus alascana Jordan and Clark.

This valuable marine fur-bearing animal is introduced here, like *Phocaena phocaena*, merely in connection with the company's receipts of the skins and sale of same in London. There may have been previous collections, but the first record in the "statement" is for 1854, with only 13 pelts; 1855 is but 2 better; then we have 38 for 1856, and 79 for 1857. Next follow 1858 with 116, 1859 with 196, 1860 with 186, 1861 with 176, 1862 with 403, 1863 with 655, and 1864 with 977 pelts. Afterwards the trade has been good, with 2,086 for 1865, and only three years under that figure, while the sales vary between 2,151 and the maximum, 13,620, in 1871, subsequent to which they irregularly decline to 1,588 for 1877. The total for the twenty years is 44,322, or an average of nearly 1,846 skins a year. There is no entry of fur seals in the Hudson Bay catalogues for 1902 and 1903. In recent years, however, the company's trade of this pelt has practically ceased on the western Pacific coast, but I understand that they now sell on commission the bulk of the yearly catch of the Victoria, British Columbia, sealing fleet.

CETACEA.

WHITE WHALE.

Delphinapterus leucas (Pallas).

Common in the Arctic Sea and in the estuary of the Mackenzie River, where the Eskimos capture a number every season. Many years ago, it is said, several individuals ascended that river as far as Fort Good Hope. They are abundant in Hudson Bay, where a large number are annually captured at Fort Churchill by servants of the company; the oil is extracted, duly shipped, and sold in London. The various boat and ship discovery and Franklin arctic search expeditions have all noticed the presence of white whales in the northern sea under review. Greely gives latitude $81^{\circ} 35'$ north as its most northerly migratory observed range.

On the question of the "Northwest Passage" Admiral Sir Edward Belcher, in volume 2 page 258 of his *Last of the Arctic Voyages*, writes: "The original act was to reward any persons who, by sailing from sea to sea, proved America to be an island, and at the period the reward was offered, it was considered (I speak subject to correction), by the wording of applications to the Treasury, with the assertion 'that great benefit would arise to *commerce*.' Now, when Sir Edward Parry made good his claim, it was for the completion of *a portion* between the meridians undiscovered. The act then, . . . divided the undiscovered spaces into divisional rewards. But inasmuch as Sir John Franklin, Sir John Richardson, Dease and Simpson did not *sail through*, the rewards to which they were *most justly entitled* were *denied*. But to my mind, and to those who are deemed to possess the clearest views in such matters, it has been deemed that the solution of the question (or really that America is sea-washed on its Arctic bounds) would have been incontestably proved had any person passed down Peel's Strait *in open water* and arrived at the positions visited either by Captain Back in former times, or by Doctor Rae on his late journey (1853-54).

It has therefore been assumed by the friends of Sir John Franklin, that his ship did so pass down Peel's Strait, and was wrecked in a position which would entitle him, if living, to contest this matter. And my own opinion goes to favor those who have, by much more hazardous voyages than those made by Parry or his successors determined the *commercial interests* which may, in consequence of their discoveries, and probably will, be pursued at some future period along that *sea-washed* shore."

In this connection I would point out that the time has surely arrived for action in respect to these remote and distant shores, as well as to our immense possessions situated to the north of the American Continent. We already know that there are copper deposits of much value up there. Coal has been met with and no doubt iron and other minerals are also present in some sections. The reindeer and musk ox have numerous representatives. Wolves, foxes, and polar bears are not scarce, while many of the rivers abound in salmon and other fish. In the straits, inlets, and larger bays whales, seals, and walrus are still in abundance, and call for some attention from Canadian fishermen. Nor should it be forgotten that there are many portions of the Canada of to-day fertile and of great metallic wealth, which, but a few decades ago, were considered almost worthless; it would therefore be very unwise to assume and continue to hold similar opinions regarding the resources of many tracts of vast extent and importance, now virtually despised, which may yet prove of great worth to the Dominion.

GREENLAND WHALE—ARCTIC RIGHT WHALE.

Balaena mysticetus Linnaeus.

It was probably an individual of this large and widely distributed species which Sir Alexander Mackenzie observed when he discovered the great Mackenzie River in 1789. On that occasion he landed on an island at its mouth, which he named "Whale Island." Although old and recent traces of them were many, yet he did not meet with any Eskimos. The Eskimos who frequented Fort Anderson succeeded most seasons in killing one large whale, but seldom as many as two. Plenty reigned for many months as a result. Quite a large number of hunters were necessary for the successful pursuit of a whale. The implements formerly used were an ivory barb, with an iron or flint point, attached to a strong walrus line having an inflated bladder at the other end. A long haft of wood was used to propel the barb, which detached itself when the object was hit. This course was followed until as many as a dozen or more floats were dragged by the whale; he soon became exhausted by the persistent attack of his enemies, and when that happened they approached and by repeated thrusts lanced him to death. The fresh blubber resembles pork in color and taste. Our servants preferred to eat it raw with their dry venison. When fried, it was very rich and oily. Needless to state that the Eskimos of the arctic region are exceedingly fond of fat and oil, and that during the long winter season they consume far more of these necessary and cold-protecting foods than any other race on earth. On June 25, 1862, the tenth anniversary of his departure from Stornoway, Lewis, Scotland, the writer had his first near view of the ice-covered polar sea and of the bay named by Sir John Richardson, in 1826, after England's celebrated but hapless explorer, Admiral Sir John Franklin.^a We then and there distinctly heard one or two large whales spouting at a great rate in a narrow lane of water, which was clearly visible at some distance amid the immense field of unbroken ice. In the end of June, 1864, he had a similar experience in the same quarter. Since the advent of American whalers, however, into these narrow seas, about twenty years ago, whales are now said to be rapidly diminishing in numbers to the westward of the Mackenzie, and this will soon be the case in the narrow seas of the land-locked portions of the Canadian polar ocean. In several suitable spots on the south shores of Franklin Bay and Langton Harbor we saw some ribs, crown, and other large bones of the whale, and certain other remains, including a human skull, ancient Eskimo huts or winter houses. With the exception of two families, with one large boat, or umiak, and three kayaks, or

^a He had previously—in June, 1857—obtained a distant view, and but for a prevailing blizzard would have had an equally close view of Liverpool Bay in January, 1859.

canoes, who had been directed to come there from Liverpool Bay to meet and assist us collecting birds, eggs, etc., and one or two young men who accompanied us from Fort Anderson, we never saw any other representatives of this intelligent and interesting race in that quarter.

I think the Greenland whale has been observed by all of the arctic expeditions. Markham relates that the Nares ships of 1875-76 witnessed numerous examples of the bottlenosed species near Davis Strait, but as they do not yield much oil they are not in much request; also one dead floating Greenland whale, worth £1,000. One of Greely's party found a rib of the latter as far north as latitude 82° 33'. Upon the east side of Port Kennedy the bones of whales were found in two places, a mile apart; the lowest was 180 feet and the highest 300 feet above the sea. They were more or less buried upon a flat patch of rather rich earth and nearly a mile inland. McClintock asks: "When did the skeletons of these whales drift to their present position? When did the forest trees grow in Baring's and Prince Patrick's Land, many of which are still fit for firewood? And when were the lofty table-lands of North Devon and North Somerset scored by the immense ravines, broad and deep, with sides almost perpendicular, and rocky beds, sometimes 100 yards wide, where no rivers now exist, nor even streamlets, except during the few weeks of summer's thaw? Will geology ever solve these enigmas?"

NARWHAL.

Monodon monoceros Linnæus.

From Eskimo reports, as well as from the published accounts of various exploratory expeditions, there can be no doubt that this marine animal is at least sparingly present in almost every section of the Alaskan and Canadian seas of Arctic America. Doctor Armstrong, of the *Investigator*, has noted some among the mammals observed by him; Sir John Ross, Sir George Nares, and other explorers refer thereto, while General Greely gives latitude 81° 35' north as its highest migratory range. Several skeletons and one tusk weighing about 14½ pounds and 7 feet 9½ inches in length were found on Boothia Felix during the stay of Admiral Sir John Ross's party there from 1829 to 1833, when they abandoned their ship and retreated by boat to Barrow Strait, where they were rescued by a whaler, at one time commanded by Ross himself. Doctor Armstrong, the accomplished surgeon and naturalist of the *Investigator*, has written that in the large western islands (Baring and Melville), "where the soil is arenaceous, animal life is more abundant than elsewhere; this gradually decreased as we proceeded to the eastward, where the limestone formation generally prevailed. But the greater number of bears, seals, walruses, and sea fowl met with, although these are more difficult to procure than

musk oxen or reindeer, by their great size afford sufficient compensation; the carbonaceous element of the food (fat), the great supporter of respiration and life, being so largely supplied."

HARBOR PORPOISE.

Phocæna phocæna (Linnaeus).

In the oft-referred-to statement of London fur sales, half skins of the porpoise appear without a break from 1856 to 1869, inclusive (I can not say if any were previously secured for export); then we have the columns for 1870 and 1873 blank, while the catch varied between 4 (the lowest) in 1862, 5 in 1863, 6 in 1864, and the highest (2,278) in 1865. The total sales for the twenty years amount to 14,048 half skins—equal to, I presume, 7,024 killed porpoises. As neither Dr. Robert Bell nor Mr. Preble mention this animal, it is probably not an inhabitant of the waters of Hudson Bay, and must, therefore, be considered as a product of Labrador seas.

The discoverer of the great Mackenzie River, which figures so frequently in these notes, and from which a large amount of material was forwarded to the Smithsonian Institution, and which has also for a long time been, and still is a valuable and rich fur preserve, surely deserves some notice, especially by a later fellow-townsmen. The celebrated fur trader and explorer, Sir Alexander Mackenzie, was a native of Stornoway, Lewis, Scotland, who emigrated to Canada in 1779, and soon after engaged in the fur trade, and in time became a partner and leader in the Northwest Company. In 1789 he discovered and descended the Mackenzie River to its outlet in the Arctic Ocean. In 1793, by way of Peace River, he was the first white man, with matchless prudence and fortitude, to force his way across the Northern American continent, and there, in latitude 52° 20' north, left his mark on a rock by the seaside bearing the inscription: "Alexander Mackenzie from Canada by land the twenty-second of July, one thousand seven hundred and ninety-three." Mackenzie's discoveries added new regions to the realms of British Empire and commerce, and in doing so extended the boundaries of geographical science. He did much more, and but for his labors it is doubtful if any part of that country would to-day be a portion of the Canadian Dominion. Mackenzie is described as "possessed of a vigorous intellect and a fine physique, of medium stature, square, muscular build, very strong, lithe, and capable of enduring great fatigue. He was a remarkably fine-looking man, firm and dignified, refined and noble in thought, with a mind and energy bent on enterprise, and filled with zeal for the benefit of his partners in trade, and with a desire for the well-being of mankind in general." He died in Scotland on the 12th of March, 1820.

Another great explorer and trader of the Hudson's Bay Company, the notable Chief Trader Thomas Simpson, likewise calls for some proper reference herein. He was a native of Dingwall, in the county of Ross, North Britain, and entered the service of the company as secretary to his relative, the resident "emperor-governor," Sir George Simpson. He left Fort Garry, Red River, on December 1, 1836, for Fort Chipewyan, whence he was to set out in company with the prudent, capable, and experienced Chief Factor Peter Warren Dease (the builder and provider of Fort Franklin, on Great Bear Lake, where Sir John Franklin passed the winter after his return from his second overland expedition to the northern coast in 1826), in order to complete the exploratory work of that party west and east of the mouth of the Mackenzie River. All know how well these officers performed the duties intrusted to them. A perusal of Simpson's narrative of their explorations should prove inter-

esting to Canadians. General Sabine, who revised the same, wrote as follows: "I found the work in a state of such complete preparation that the alterations which I saw any occasion to make were very few indeed, and these chiefly of a verbal nature. It impressed me with an additionally high respect for your brother's memory, that he should have drawn up the narrative of the expedition on the spot in such a complete manner that it might quite well have been printed verbatim." On the 6th of June, 1840, Simpson, who had returned to Fort Garry on the preceding 2d of February, after an absence of three years and two months, marked by toils, perils, and privations such as have seldom been endured, set out for England by crossing the prairies to St. Peter's (St. Paul and Minneapolis were not in existence then), and thence to New York. He pursued his journey with much rapidity, left the main body of buffalo hunters with whom he started, and in company with four men went on ahead. On a chart which was found among his other papers after his death his last recorded day's march (June 11) was 47 miles in a direct line. After that date every circumstance is involved in mystery. He had evidently turned back, and all that can be ascertained with certainty is that on the afternoon of the 13th or 14th of June he shot two of his men, and that the other two mounted their horses and rejoined the large brigade of hunters. A party of them went to the scene of the shooting next morning, where his death took place. Whether he shot the two men in self-defense, and was subsequently killed by their companions, or whether the severe stretch to which his mental faculties had been subjected for several years brought on a temporary aberration of mind, under which the melancholy tragedy took place, is known only to God and the surviving actors therein.

"Man is a harp, whose chords elude the sight,
Each yielding harmony disposed aright;
The screws reversed (a task which, if he please,
God in a moment executes with ease),
Ten thousand thousand strings at once go loose,
Lost, till he tune them, all their power and use."

Thus perished, before he had completed his thirty-second year, Thomas Simpson, a man of great ardor, resolution, and perseverance, one who had already achieved much, and has left a name which will be classed by posterity with that of Cook, Parry, Lander, Franklin, Rae, Ross, McClintock, and others of a later date. The Royal Geographical Society presented to him in 1839 their founder's gold medal, which, however, never reached him. It was not until October, 1841, that the remains of Simpson were sent for from where he fell and brought to Fort Garry for interment.

RODENTIA.

BUSHY-TAILED WOOD RAT.

Neotoma drummondii (Richardson).

Chief Trader W. J. McLean informs me that Fort Liard, Mackenzie River District, where he was post manager from 1863 to 1872, is the only place in the northern department of the company where he has seen a few examples of this rat. This post is situated in latitude (about) 60° north and longitude 124° west. In New Caledonia District, British Columbia, however, it is quite common, and individuals are sometimes secured in native and other buildings. At present, Fort Liard may be considered the eastern range limit and the northern as well; but it is probably a more northerly resident on the west side of the Rocky

Mountains. Mr. Moberly states that a wood mouse or rat, color light brown inclined to gray, and about 5 inches long, was repeatedly seen by him at Fort McMurray, but nowhere else on this side, although not uncommon in New Caledonia, British Columbia, where the people speak of it as the "small wood rat."

WHITE-FOOTED OR DEER MOUSE.

Peromyscus arcticus (Mearns).

Although we failed to secure any specimens of this mouse at Fort Anderson, it may still be discovered in the country to the northward of Forts Liard, Simpson, Resolution, Rae, and Big Island, from which points numerous examples were obtained by Messrs. Ross and Kennicott, and forwarded to the Smithsonian Institution in the years 1860 to 1862. Mr. Moberly mentions the existence in the region of Athabasca and Peace rivers of a brown wood mouse, which destroys martens and other fur animals caught in dead-fall traps.

I incline to think that this mouse ranges farther north than the several Mackenzie River District posts (Forts Simpson, Liard, Big Island, Rae, and Resolution), from which specimens were forwarded to Washington by Messrs. Kennicott, Ross, Kirkby, Clarke, Reid, Brass, and Mackenzie in the early sixties of the last century. From the description given, I think Mr. P. Deschambault met with this species, both at Isle à la Crosse and at Lac du Brochêt post, situated at the northeastern end of Reindeer Lake.

RED-BACKED MOUSE.

Evotomys sp.

A fairly large number of examples of this species was collected by the Eskimos on the polar shores of Liverpool and Franklin bays, and in the adjacent country of the lower Anderson and Mackenzie rivers. Some were also taken in the vicinity of Fort Anderson and from the eastern Barren Lands. At nearly all of the company's posts in the Mackenzie River District likewise a number of skins were obtained for the Smithsonian Institution, and the gentlemen of the service above named were the contributors, together with Messrs. Hardisty, Wilson, Lockhart, A. Flett, J. Flett, W. Thomson, Smith, Gaudet, Taylor, Sibbiston, McDougall, Camsell, and MacFarlane.

Among the many northern Mackenzie River collectors of those distant days, to whom reference was made in my paper on birds breeding in Arctic America, as well as those specially referred to in these notes, but few besides the writer are now living. I think they are Chief Factors James McDougall and J. S. Camsell, Chief Traders C. P. Gaudet, W. J. McLean, and William C. King, and Messrs. Murdo McLeod and John Edward Harriott. Archdeacon W. W. Kirkby, D. D., now of Rye, N. Y., and Archdeacon Robert McDonald, D. D., of Peel River, also ranked among the number of successful Smithsonian collectors of the early sixties of the last



FORT RESOLUTION, GREAT SLAVE LAKE.

century. Among those who have passed away are the lamented naturalist, Robert Kennicott; Chief Factors William L. Hardisty and Lawrence Clarke; Chief Traders Bernard R. Ross, James Lockhart, John Wilson, and John Reid, and Messrs. Strachan Jones, A. Mackenzie, Andrew Flett, James Flett, J. Sibbiston, and William Brass; also the recently deceased Bishop Grandin, D. D., of St. Albert, Alberta, who contributed more than one interesting specimen during his former mission sojourn in the Mackenzie District. Neither has death spared the Smithsonian Institution. The eminent Professors Henry and Baird, together with the able Assistant Secretary, Dr. G. Brown Goode, the genial and experienced zoologist, Maj. C. E. Bendire and others, have been called away.

MEADOW MOUSE.

Microtus drummondi (Audubon and Bachman).

Quite a large number of skins were forwarded from Fort Anderson to Washington. They were obtained from the Eskimos of the Mackenzie and Anderson rivers, while a few were secured in the neighborhood of the fort. In severely cold winters individual mice are often found dead in stores and outhouses, and also on the snow in sparsely wooded tracts of country. Disease may, however, be sometimes the real cause of death. Some Indians assert that some species of mice breed oftener than once annually.

LITTLE MEADOW MOUSE.

Microtus macfarlanei Merriam.

The Indians, and especially the Eskimos, who resorted to Fort Anderson, supplied a large proportion of the specimens received by the Smithsonian Institution from the Mackenzie River region, in course of the years from 1861 to 1866, inclusive. There are seasons during which mice are exceptionally abundant in different parts of the great Canadian northwest.

CHESTNUT-CHEEKED MOUSE.

Microtus xanthognathus (Leach).

This comparatively large mouse is very abundant most seasons in the far north, as well as along the arctic coast of Canada. Numerous skins thereof were secured at Fort Yukon (Alaska), Forts McPherson, Anderson, Good Hope, Norman, Simpson, Big Island, Rae, and Resolution, Great Slave Lake.

TAWNY LEMMING.

Lemmus trimucronatus (Richardson).

From the polar shores of Liverpool Bay and Cape Bathurst, from the lower Anderson River, from the neighborhood of Fort Anderson, from Fort McPherson on Peel River, and from Fort Yukon in eastern Alaska, many examples were obtained of this small animal, which

were forwarded to the Smithsonian Institution at Washington some forty years ago. From the published records of arctic exploration, there can be little doubt that at least two species of lemmings are comparatively abundant, even at the highest attained latitude, at many points of the northern polar lands of the Dominion of Canada visited by the various ship expeditions.

On Baring Island, Doctor Armstrong found them numerous in many localities, at most periods of each season, and also in large numbers on the ice during the spring thaws. He also knew them to prey on each other, has himself partaken of their flesh, and thought it delicately nice and tender. He writes that the female lemming produces from two to six at a birth. Sir Edward Parry found two species of lemming equally abundant on Melville Island; he gives the number of young as varying between four and eight. A female captured in 1820 had four *in utero*. On July 12, he discovered a nest containing six blind, naked, and helpless little ones, which grew so rapidly that they were able to quit it ten days later. Lemmings subsist on the products of the soil, such as dry dwarf willow, grasses, etc. Sir James Clark Ross states that lemmings were very abundant in Boothia, and he also confirms the above birth references from his observation. Captain Markham, of Sir George Nares' expedition, met with lemmings on his North Pole expedition of 1875-76, while General Greely found them in large numbers on Grinnell Land, as far north as latitude 83° 24' north. Eight examples were secured by his party during their stay in that quarter. They live in comfortable nests, composed of dry grasses, in holes in the ground, with two entrances to each. Sir John Ross found the skeleton of a lemming on an ice floe 60 miles north of Spitzbergen, in 1827.

HUDSON BAY LEMMING.

Dicrostonyx richardsoni Merriam.

This species is decidedly more abundant than *Lemmus trimucronatus* in Arctic America. A considerable number of skins was collected in various conditions of pelage from midsummer to midwinter, not only in the vicinity of Fort Anderson, but also from the lower Anderson River, the Barren Grounds, and on the coast shores of Liverpool and Franklin bays. Two females secured in the "Barrens" on June 26, 1865, each contained five embryos, while a few days later (June 30) a dead male example, perfectly white, was discovered in the nest of a golden eagle, 2 or 3 miles to the west of our usual summer crossing of the Wilmot Horton River.

MUSKRAT OR MUSQUASH.

Fiber zibethicus hudsonius Preble.

Like most of the important fur-bearing animals, the musquash greatly fluctuates in number. We have usually several seasons in succession when they are very abundant, followed by quite as many when they are comparatively scarce, and then between these periodic fluctuations we have a year or two when the returns are either above or below the average trade, as will now be demonstrated. From 1853 to 1877, the company sold in London 10,600,056 musquash, or an average of about 424,000 skins a year. Outfits 1853 and 1854 exceeded this result. They yielded, respectively, 493,952 and 512,291; but the following nine sales (1855 to 1863) were all below the average, and ranged between the period minimum (177,291 skins) in 1860 and 357,060 in 1863. There was a material increase in 1864 (509,769 skins), then three years of decline (418,370, 320,824, and 412,164 skins). However, 1868 gave as many as 618,081 skins, after which the two succeeding seasons fell below the average (404,173 and 232,251 skins), and the statement of sales winds up with seven good years, varying between 437,121 skins in 1877 and 768,896 skins in 1873, which was the best of the series.

The musquash abounds in all suitable localities throughout the entire Northwest Territories of Canada. It is abundant in marshy tracts on both sides of the mountains. It is also very common on the lower Mackenzie River, and less so on the same portion of the Anderson River, to their outlets in the polar sea. Albino examples are occasionally met with, but in all sections of the country formerly ruled by the Hudson's Bay Company a few skins of a fine dark variety of this species are annually secured by the native and other hunters. Seasons of high water, however, are a necessary factor in the propagation of the muskrat, while summers of drought and continued low water curtail expansion and also cause many deaths during the succeeding winters. In corroboration of this view I would offer a few remarks. The outfit 1889 was my first of five years' charge of the Cumberland District, lower Saskatchewan. The stage of water that autumn was fairly good in the many marshy streams, small lakes, and ponds in this musquash country (probably the best in western Canada), and the returns therefore quadrupled those of the preceding season. The following year was dry, and both water and the musquash catch shrunk considerably, while many thousands of the animals perished miserably under the ice and in their frozen up "washes," or winter houses. This unfortunate occurrence adversely affected results for two or three years, but in the meantime water conditions improved and have been very favorable for the last decade, so much so, indeed, that the annual

catch of musquash therefor has more than doubled that of any of the previous ten years in the district's history. In fact, I believe it turned out about 450,000 skins for outfit 1900. When very numerous, epidemic liver disease appears and carries off many thousands of musquash. Last year's Cumberland returns declined nearly two-thirds, and they may go still lower for this season, after which they will, as usual, rapidly increase again in numbers. More attention than before is now given to the hunting of the musquash in this and other districts, and as a result the company's sales are very considerably above the average of former years. In January, 1897, they sold 492,244 skins; in January, 1900, 756,910 skins; in January, 1901, I am told that the sales bordered on 2,000,000 skins; in January, 1902, 1,650,214 skins, and in January, 1903, 1,482,670 skins. This last showing is only 53,122 skins less than double the figures for the best sale (1873) entered in the London sales statement. The aggregate total for the period was 10,600,056 skins.

Leading hunters at the Pas, Cumberland, state that when about a year old the musquash begins to breed. The female has but two litters the first and three each succeeding season for a time. The number of young brought forth at a birth varies between 8 and 20. When born, they are weak and blind for some days, but they soon acquire sight and strength and learn to swim about and aid in providing for their own gradually increasing wants. Their food consists of esculent grasses and aquatic roots of various kinds. As already mentioned, many thousands of musquash die of disease, and many other thousands perish in seasons of low water. Mr. Colin Thomson, an intelligent observer, remarks:

They have an instinctive habit which those who hunt them would do well to learn. They have a general residence in which they live and exercise their natural instincts; to this residence a storehouse is attached at a little distance, in which they put up many dainty and succulent roots against the "rainy day" and a long winter; and when misfortune drives them from their homes, they are not without a refuge, although it be but a small one. The material used in the construction of their houses is such as they find in the marshy swamps where they live, and it is not uncommon to find the entire family of a season living in one house, sometimes as many as sixty in all.

Another informant, speaking of his own experience at Frazer Lake, British Columbia, and of his residence at posts on the Saskatchewan, Athabasca, and Peace rivers, writes that "the musquash copulates in the months of May, June, and July; that the females have three litters each season—the first being the most numerous, the second less, and the third, the least fertile in the series—that they are born sightless, and that the male assists in the rearing of the young."

JUMPING MOUSE.

Zapus hudsonius (Zimmermann).

In the early sixties of the nineteenth century the Smithsonian Institution at Washington received from Liard River, Fort Resolution, Great Slave Lake, and from the Peace River several examples of this mouse, but from report I do not think it is very common in these localities. Mr. B. R. Ross states that it is numerous in the Portage La Loche country, but rather rare in the district of Mackenzie River, but I do not remember having seen any at Good Hope or the Anderson. They may, however, be sparingly represented by examples at Liard and other points in the distant north. Mr. P. Deschambeault informs me that he has seen some jumping mice both at Isle à la Crosse and Lac du Brochêt. Mr. Moberly has also met with them on the Athabasca and Peace rivers.

POLAR HARE.

Lepus arcticus Ross and *L. grœlandicus* Rhoads.

I doubt if this hare is "abundant" in the Barren Grounds, or on the coast shores of arctic Canada, with the exception of the isthmus of Boothia Felix. We hardly ever observed an individual on our many summer and winter journeys in the far Northland, while I think we secured but three specimens during our five years' residence at Fort Anderson. Two or three skins were also obtained by Chief Factor Lawrence Clarke from the Barrens northeast of Fort Rae, Great Slave Lake. They are said to be fairly numerous among the tundras of northern Alaska, while arctic explorers have found the polar hare "very abundant" on the large islands lying to the north of the American Continent. On Baring Island they were in considerable numbers and many were shot. The *Resolute* obtained 146 on Melville Island and Ross secured some in Boothia. Nares met with them on his polar expedition, and Greely's men captured 57 examples. He gives latitude $83^{\circ} 24'$ north as its highest northern range. Lieutenant Lockwood killed 1 at Cape Benêt on the coast of northwestern Greenland. Captain Markham of the *Alert* observed traces on the polar frozen sea, 10 miles from the nearest land, in latitude $83^{\circ} 10'$ north. Doctor Armstrong also mentions that individuals were occasionally seen on the ice at a distance of 2 or 3 miles from the shore. He asserts that they breed three or four times in the course of an arctic season, and that the females have as many as eight and ten at a birth. This seems both extraordinary and improbable, but the doctor was a close observer and had had three years' experience of Baring Island and its fauna. Sir James Clark Ross, on the other hand, writes that a female shot at Sheriff harbor, Boothia, on June 7, 1832, had four

young *in utero* nearly mature, each $5\frac{1}{2}$ inches long, and of a dark gray color. In the uterus of one killed at Igloodik on June 2, six young were found, not quite so far advanced. One taken by Ross himself on June 28, a few days after birth, became sufficiently tame to eat from the hand but it died fifteen months later. He remarks that the polar hare exists even in the most desolate sections of the arctic regions, and that, too, throughout the long winter; nor does it seek shelter by burrowing in the snow, but is often met with sitting under the lee of a large stone where drifting snow has accumulated and seems to afford some protection from the biting blast. Doctor Armstrong, however, holds that this hare, as well as white foxes, lemmings, and the very few native birds all burrow in the snow at times during the winter for the sake of warmth.

NORTHERN VARYING HARE.

Lepus americanus macfarlandi Merriam.

Australians used to complain bitterly of the great havoc committed by the introduced English hare, or rabbit, and at one time the government offered as much as £20,000 for the discovery of a remedy which would have the effect of extirpating the nuisance, or at least considerably reducing the rabbits in number. We of the north then thought that if the latter could be inoculated with the virus of the disease which periodically affects the head and throat, and carries off many thousands of the American hares, when they are most abundant, in each decade, it would doubtless be highly appreciated in Australia, while, on the other hand, the natives and others resident in the eastern, western, and northern territories of Canada, would be greatly pleased if the referred-to epidemic would recur in a less fatal form and thereby prevent the years of scarcity frequently experienced. As already stated in this paper, there are several fur-bearing animals, notably the lynx and marten, whose numbers would seem to be chiefly dependent upon the abundance or scarcity of this species. The yearly catch of lynxes rapidly diminishes in volume as soon as the rabbits become scarce, and when the latter are comparatively rare a large proportion of the great, but now dwindling crowd of lynxes suffer privation, and some actually starve to death. Indians occasionally find examples of such victims. Nearly every post in the Mackenzie River District sent one or more specimens of the American hare to the Smithsonian Institution. It is said that it breeds two and three times each season; that the sexes copulate in the end of March, May, and August; that the period of gestation lasts about three weeks, and that the female seldom becomes a mother before she is a year old. A litter usually consists of three or four; but when on the "periodic" increase, females are known to have as many as six, eight, and even ten at a time, and then gradually return to three and four. The young are not born blind, nor, so far

as known, does the male render any assistance in rearing them. I am not able to substantiate this statement by my own experience.

The Hudson's Bay Company does not trade rabbit skins in the interior, but from the posts situated on the shores of Hudson Bay they annually export to England many thousands. From 1853 to 1877 the total amounted to 1,418,361 skins. Twelve of these years had sales varying between a minimum of 1,036 in 1871 to 45,917 in 1869, and then from 50,948 in 1876 to the maximum sale of 174,715 in 1855. The three next years of the series turned out 141,403 in 1865, 143,930 in 1867, and 106,320 in 1868. Subsequent to 1877 I have no data, except for January, 1897, when 81,759 skins were sold; January, 1900, with 18,372, January, 1902, with 5,857, and January, 1903, with 16,873 skins. The pelt of this valuable food animal is of great service to northern Indians, who cut up the fur skins into narrow strips and therewith make them into robes for their women and children and tunics or shirts for the men for winter use, and these garments certainly prove warm and comfortable for them. The American hare does not inhabit any of the large islands situated to the north of the continent. It is there replaced by *L. arcticus*. Neither did McClintock at its extremity (Bellot Strait) nor Ross at near its center on Boothia Felix meet with any examples or traces thereof on that far extending northeastern portion of Canada's continental territory.

LITTLE-CHIEF-HARE.

Ochotona princeps (Richardson).

Although I have never made the acquaintance of this hare-like mammal, yet from what Mr. Moberly states I incline to think that it is to be found sparingly on both sides of the Rocky Mountains as far north as latitude 60°—Richardson's northern limit. Moberly also refers to a rabbit about the size of *Lepus americanus*, of a grayish color, which does not change to white in winter, while its movements are very swift. Indians informed Mr. Ross that little-chief-hares were common in the mountains of the Liard River, while Jack McQuesten obtained some specimens on the upper Yukon, about 200 miles south of the old fort and in about latitude 63° north.

CANADA PORCUPINE.

Erethizon dorsatus (Linnaeus).

Porcupines are but rarely met with in the wooded country of the northern Anderson River, but in the region to the south they are somewhat more numerous, though nowhere in the far north very abundant. It is said that they copulate in September, and that the young are not brought forth until the following April. They are usually one or two in number, and, like most mammals, are born blind and

helpless. They nest in rock-sheltered holes. The male renders no assistance in rearing his offspring. They spend much time among the trees, on which they subsist. Indians consider them the most insolent and the clumsiest of animals. Neither Doctor Russell nor the Messrs. Preble met with this species on their recent arctic and Hudson Bay expeditions. Mr. George Deschambeault says that the period of gestation lasts about twelve months.

YELLOW-HAIRED PORCUPINE.

Erethizon epixanthus Brandt.

The northern Indians concede that there are two kinds of porcupines in the Canadian territories. This species, however, is more numerous toward the Rocky Mountains, where it probably replaces *E. dorsatus*. The flesh of the porcupine is considered excellent eating, not only by the natives but by all who have partaken thereof. Some hunters state that the females bring forth two and three at a birth. The Slave tribe of Indians inhabiting the Liard and Mackenzie rivers dye the quills of various colors and weave them into belts, garters, bands, bracelets, and rings for table napkins. They also ornament bark rogons and other birch articles, women and children's dresses, and the front uppers of leather moccasins therewith. Mr. P. Deschambeault says that he believes both species exist in the hunting grounds of the Isle à la Crosse (English River district) and Lac du Brochêt (Cumberland district).

BEAVER.

Castor canadensis Kuhl.

This well-known and valuable fur animal has been so fully described by travelers, as well as naturalists, that it is by no means easy to add matter of interest to its history. I shall, however, venture to submit a few items bearing thereon. From a consensus of statements and opinions elicited by me from the examination of aged Chipewyans, of Athabasca, and Carrier Indians of North Caledonia, British Columbia, I believe that the sexes copulate in the months of January and February, and that the young are brought forth in April and May following. The period of gestation is about three months. The young are born blind and are very helpless, but both sight and strength are duly acquired, and they soon display much activity. They are suckled for some weeks, but early learn to feed on succulent stems and the tender roots of aquatic and other plants. The most prolific females are those of middle age, and they annually produce from four to five and six at a birth, while instances of as many as seven and even eight are not infrequent on Peace River. Chief Trader Moberly has known of two cases, in one of which the female had eight and in the other nine little

ones. A Chipewyan hunter also assured me that he once found as many as nine well-formed embryos in the uterus of a female killed by him on the lower Peace River. Both tribes state that the female beaver seldom or never has young before the third year and that there are only one or two cubs at first, but more the following seasons. After attaining a certain stage in life the birth rate begins to decline. The adult beaver subsists on various roots, poplar bark, green willows, birch, and other deciduous leaves. The male assists in providing food for the young in the earlier stage of their existence. When necessary, this intelligent animal erects new, and always renovates old, lodges and dams in the autumn. One or two kindred families frequently live together, and their progeny continue for upward of two years with their parents, after which they are usually expected to mate and provide for themselves. The males often fight fiercely during the rutting season. It is not an uncommon experience for hunters to find one or more beavers dead of disease in their houses or "washes." Such animals are seldom other than in good condition, but the Indians will not eat the meat except they be verging on starvation. In this connection, Mr. G. Deschambeault writes that "when beaver are found dead in their 'wash' they are generally (mouth and nostrils) infested by numerous small white worms. Low water also causes the death of beaver some winters in their lodges." Some old veteran males become very large and heavy. The flesh of the beaver, except when very lean, is very palatable and easy of digestion, and is much relished by the natives and northern resident whites who have partaken thereof.

If let alone, or not much disturbed by hunting, the beaver will rapidly increase in numbers. In proof of this statement, I would mention that many extensive tracts of country in which they had become scarce or had wholly or almost entirely disappeared (as a result of the keen and very costly rivalry in trade which had for many years existed between the Northwest Company of Montreal and the Hudson's Bay Company of England previous to their coalition in 1821, it was uncertain for some time "which of them lost most money—neither of them gained money," while the general demoralization of Indians and whites was very lamentable) they afterwards recovered under the fostering policy of protection promptly inaugurated and intelligently pursued by the now united Fur Trading and Governing Corporation. For more than a decade subsequent to 1821, each beaver district in the chartered and licensed territories of the Hudson's Bay Company was annually restricted to the collection of a certain fixed number of beaver, which course eventually proved of much benefit to all concerned. By this means the perpetuation of the beaver was insured in sections where reckless slaughter had almost exterminated it, while the resulting expansion in more forward localities naturally followed. With

the view, however, of reconciling them to this enforced mode of preservation, the natives were strongly urged and encouraged to devote their best energies to the trapping of martens and other fur-bearing animals. After the beaver were known to have largely increased in numbers, and still sold well, the above rule was gradually relaxed; and as the wants of the Indians in those days were comparatively few, they never experienced any particular hardship from the limit thus imposed upon them in the general interest. It may be here mentioned that the company never encouraged the hunting of beaver or any other pelt *out of season*. On the contrary they strictly prohibited the killing of beaver in summer, and would only reluctantly accept the skins of such animals as they were assured had been absolutely necessary for food purposes.

The introduction of nutria and silk in the manufacture of hats in the early forties of the last century struck a deadly blow at the value of beaver, the chief staple fur of Canada and the northwest for two centuries, from which it has not yet quite recovered. For nearly half a century thereafter, the prices annually obtained for pelts were some 60 and 70 per cent below the average which had previously ruled. Since the Alaska fur seal, however, has come into "fashion," very much better rates have been realized by the smaller quantities of beaver sold in recent years. With the view of obtaining better prices in England, as well as for its future increase in numbers, the company naturally favored a continuation of its beneficial policy of restriction; but owing to the then general abundance of beaver, and the advent of competition in the trade, this much desired course had to be gradually abandoned. For the twenty-five years, from 1853 to 1877, the Hudson's Bay Company sold a total of nearly three million skins (2,965,389) of this important animal in the world's fur mart, London. The yearly catch from 1853 with 55,456 pelts to 87,013 in 1858 exhibited a steady increase. The year 1859, with 107,196 pelts, was, I believe, the first to reach and exceed the century mark since the union in 1821, but 1860 dropped to 91,459. While 1861 was only 926 skins below 1859, 1862 produced 115,580 pelts, 1863 produced 114,149, and 1864 produced 142,998, yet the last-mentioned year's sale was immediately followed by a decline of 24,750 pelts. The balance of the series from 1866 to 1877 varies between the minimum, 115,646 in 1877, and the maximum, 172,042 in 1867, certainly the highest and best since 1821, and probably one of, if not, the most productive in the history of the Hudson's Bay Company. An old writer of repute, however, writes that 175,000 beaver skins were collected by the "ancient concern" in one year about the middle of the eighteenth century. It is possible that this large number may have comprised the country trade of two seasons. European wars were rather frequent and somewhat protracted in those days, while it is on record

that one or two of the company's ships failed in making the annual round voyage between London and Hudson Bay. I think it is a matter of regret that neither of the two recent historians of the Hudson's Bay Company, while throwing much light on the earlier and some of their later trade operations, have not also given us some definite statements of their yearly fur shipments and sales, which would have been generally appreciated. Mr. Beckles Willson has, however, given an interesting account of the company's first London public sale, which took place on January 24, 1672. On this occasion the 3,000 weight of beaver were put up in thirty lots, and fetched from 36 to 55 shillings (a pound probably). The other furs and peltries, bear, marten, and otter, etc., were reserved for a separate and subsequent auction, while previous receipts from the bay had been disposed of by private treaty.

This first official sale, as it subsequently proved, of a series of great transactions which for upward of two centuries have made London the center of the world's fur trade, excited the greatest interest, and both the Prince of Wales and the Duke of York, besides Dryden, the poet, were among the many spectators. Previous to the advent of Canadian traders from the east, the Indians of the surrounding country were wont to assemble in the spring at Lake Winnipeg to the number of perhaps 1,500, where also birch-bark canoes were built. Six hundred of these containing a thousand hunters, exclusive of women, came down annually to York factory with furs to trade. Beaver were very numerous in those days, and a great many were wasted in various ways, often as clothing and bedding. Not a few were hung on trees as native offerings upon the death of a child or near relation; occasionally the fur was burned off, and the beaver roasted whole for food banquets among the Indians.

He further states that in 1742, two large expeditions of natives from the interior came down to York and Churchill (Fort Prince of Wales). One of them had 200 packs of 100 skins each (20,000 beaver, probably from Lake Winnipeg country), and the other 300 packs of 100 each (30,000 beaver and 9,000 martens). This made a total of 50,000 beaver received from both "expeditions." I take it that these came from the Chipewyan Indians of the distant Athabasca and intervening country, reaching Churchill by way of the English and Churchill rivers.

Doctor Bryce, in his concise history, writes that so effective and successful were the operations of the great Northwest Company of Montreal, that toward the end of the eighteenth century, a single year's trade produce was enormous, and comprised 106,000 beaver, 32,000 martens, 11,800 minks, 17,000 musquash, and 17,000 skins of other animals. Still, if we knew the total Hudson's Bay Company's catch for that year, I doubt if both returns of beaver would much exceed the total of 172,042 skins, given in the London fur sale statement for 1867. From 1858 to 1884, the district of Athabasca contributed 445,014, or an average of 17,116 a year to the company's London sales. The average for the selfsame posts for the five outfits

(1885 to 1889) is about 8,000; and with the "opposition" trade added from 1890 to the spring of 1903, both will undoubtedly exhibit a further decline. From 1863 to 1883, Mackenzie River District exported a total of 183,216 beaver, giving an average of 11,822 a year. For the three years (1886, 1887, 1889) of which I hold data, it had fallen to 6,852, and is, I fear, very much lower at the present time. These are but samples of the general decrease in beaver receipts experienced at every trade competing point from Quebec to the North Pacific and from the international boundary to Hudson's Bay and the northwestern limit of its range in arctic America.

It is now well known that for some years prior to the coalition in 1821, the annual catch of beaver was rapidly dwindling, and that in several sections it had been exterminated by reckless slaughter; another decade or two of similar trade competition, would doubtless have led to its extinction, except for a time in retreats remote and difficult of access. We have had ample proof, however, by obtained results, of the beneficial operation of the wise and far-reaching policy adopted by Governor Sir George Simpson and the able and experienced fur-trade counselors of the then united companies, for the due preservation of this valuable animal. For some years before and after the transfer of the country to Canada in 1870, the entire Peace River, together with many other streams and small ponds, throughout the Territories, British Columbia, the Yukon, and the east were swarming with beaver; but this, unfortunately, is not the case to-day. From 1853 to 1877, inclusive, the average number of skins sold by the Hudson's Bay Company in London, was 118,615, as against their total catalogue sales of about 50,000 for 1897, 43,000 in 1900, 46,000 in 1902, and 49,190 for 1903. This is without doubt a bad showing for some of the later of the twenty-six years which have succeeded that statement. Even with the addition thereto of the "opposition" trade, in the very same locality, it is doubtful if the aggregate of both would greatly exceed one-half of this average. It is generally assumed that "opposition" or competition is the "life of trade" in all branches of business; but, in the opinion of many competent judges, the fur trade, from its very nature and the scope of its operations, is, or should be, one of the few essential exceptions to the rule. It is a matter of fact that the advent and continued presence of "free traders" at a company's inland post has always had a more or less stimulating effect on the natives by inducing them to exert themselves to a larger degree than usual in the hunting of beaver and all other fur-bearing animals; but although at first and for some time, all concerned appear to benefit by increased returns, yet the inevitable accompaniment of reckless and indiscriminate slaughter, sooner or later, adversely manifests itself. This has hitherto been the invariable experience at every assailed post or district in North America.

We all know how the bison or buffalo of the prairies of Canada and the United States has practically disappeared, although half a century ago it was reckoned by millions. The beaver has been Canada's staple fur for centuries, and but for the Hudson's Bay Company and its officers it would long ago have ceased to exist as a commercial asset. Unless further action speedily intervene in the premises, however, the ultimate extermination of the Canadian beaver is merely a question of time. It has already disappeared for good from many sections in which it was formerly present. It is becoming very scarce in certain localities where it should receive immediate protection in the way of several legally-assured years of rest and full exemption from disturbance by hunters. In other districts, where it is gradually but surely diminishing in numbers, its killing should be restricted on lines similar to those pursued by the company for many years subsequent to 1821. Greater latitude might be accorded to hunting in now unknown and not easily accessible parts where it probably abounds; but except for food absolutely required no one should be permitted to trap or shoot beaver *out of season*. It is useless making rules and regulations, however, unless they be strictly enforced. The woodland buffalo is now receiving some well-deserved attention in this regard, and it is about time that the musk ox should be protected from indiscriminate slaughter solely for the sake of his head or hide; there should be a seasonable limit imposed upon hunters thereof. Neither should the mountain goat and sheep, the elk, and the valuable food animals—the moose and woodland caribou—be neglected in this connection. And although the Barren Ground reindeer is still abundant, yet the northern Indians should not be permitted to continue or resume their ancient vicious course of reckless and indiscriminate slaughter of them whenever the opportunity appeared.

From Fort Anderson and nearly every other post, including Fort Yukon, skulls and other parts of the beaver were obtained for transmission to the Smithsonian Institution at Washington. While stationed at Fort St. James, British Columbia, in 1887 and 1889, I sent to the same Institution two embryo skins taken from the uterus of a female killed in the vicinity early in May (there were five in all), together with that of a 2-weeks-old example captured in the latter end of the same month. As to albinos, they are very rare, but I have seen perhaps as many as ten skins in course of my long residence in the Northwest Territories. I have also observed quite a number of fine dark skins of the beaver in various parts of the country. I think those taken by the natives of Quebec who resort to Bessimis post in the Gulf of St. Lawrence are among the very finest. Labrador, East Main, and other Hudson Bay posts also furnish a small number of similar pelts. As a rule, those which frequent clear-water streams have a better color than is the case with the summer inhabitants of very

muddy rivers having their source in or beyond the Rocky Mountains and flowing through a sandy clay soil. The skins of such beaver are usually of a dirty rusty brown color, with the inner fur of a lighter hue, and are certainly in appearance inferior to those of their cleaner-furred brethren, and must therefore realize lower prices in London.

The substance contained in two pyriform sacs situated near the organs of reproduction in the beaver, and commercially well known as "castoreum," has always been traded from the natives; and although it is not entered in the aforesaid statement of sales or in the fur catalogues for 1887, 1902, and 1903, yet the company's officers annually shipped to London considerable quantities of this valuable commodity. "At one time it was largely employed as a medicine for derangement of the nervous system, but now little used." This, of course, adversely affected prices, and for a number of years castoreum did not sell well. Latterly, however, owing to its scarcity and its reported use as a base in the manufacture of perfumery, its value has been greatly enhanced. During my long stay at Fort Chipewyan, Lake Athabasca, upward of twenty abnormally large examples of castoreum sacs, or "pods," as designated in trade, containing from three to nearly five times as much of the substance as is usually found within averaged-sized specimens, were obtained, for the most part, from animals killed on the Peace River. I also noticed and heard of a few similar "pods" elsewhere in the interior; but in those days Athabasca produced the very largest I ever saw.

From certain documents in my possession I believe we can form some idea of the extent of the castoreum trade of the last century. As a rule the receipt of this article naturally corresponds with the annual catch of Beaver. Mackenzie River District from 1863 to 1881 contributed a total of 6,251 pounds weight. From 1858 to 1884, old Athabasca was premier, with 18,904 pounds, but in consequence of increasing competition in the north the average of the former for 1886, 1887, and 1889, is only 54 pounds, as against 32,918 for the period ending in 1884. The trade of the latter for the five years (1885 to 1889) gives an average of but 211 pounds as against 700 pounds for 1858 to 1884. Its former posts on Upper Peace River had not one-fourth as much castoreum in 1889 as in other years. English River district gave 40 pounds for each of the outfits, 1889 and 1890; Cumberland district only 26 pounds in 1888, and 56 pounds in 1889; and then we have New Caledonia, British Columbia, with 113 pounds for each of 1885 and 1886, and 390 pounds in 1887, 390 pounds in 1888, 402 pounds in 1889, and 231 pounds in 1890; all of these results are very much below those realized previous to the advent of (the frequently vaunted) "free trade."

NORTHERN POCKET-GOPHER.

Thomomys talpoides (Richardson).

Never having seen an example of this species I know nothing about it; but from what Mr. Moberly states it probably inhabits the banks of the North Saskatchewan in the immediate vicinity of the Rocky Mountains. He further adds that there is an allied but somewhat larger gopher on the west side, from the Kootenay to the Frazer River. It is about 2 inches longer than *T. talpoides* and has very short ears, with more brown about the body. Both kinds are good eating, and they also form an important item in the diet of the grizzly bear.

NORTHERN FLYING-SQUIRREL.

Sciuropterus sabrinus (Shaw).

Having lost some of my original field notes and several Smithsonian receipt lists, I can not feel quite sure of a few stated entries and references in this paper. I have, however, an impression that I saw a flying-squirrel north of Fort Simpson and several elsewhere in other southern tracts of territory. Some specimens were collected at Fort Liard by Mr. Hardisty, at Big Island by Messrs. Ross and Reid, at Resolution by Mr. Lockhart, and one also labeled "Arctic America" by Mr. Kennicott many years ago. In 1893, Dr. Frank Russell, of the Iowa State University, secured one specimen at Grand Rapids, where he says they are very rare. The brothers Preble, of the U. S. Department of Agriculture, have also recently obtained some skins at Oxford House and Norway House, Keewatin. Mr. Moberly writes that the flying-squirrel of the Rockies must be *S. alpinus*, as it is not found in the country to the east. Mr. Pierre Deschambeault writes that the flying-squirrel is not uncommon at Isle à la Crosse and Lac du Brochêt.

RED SQUIRREL.

Sciurus hudsonicus (Erxleben).

This species is undoubtedly the most generally distributed of the squirrel family, and it is more or less common throughout the entire timbered region of northern continental Canada. It is also numerous in Alaska, while specimens have been sent to Washington from nearly every Hudson Bay post in the Mackenzie River district. It makes its nest in a tree and has usually, once a year, from four to six, and occasionally as many as seven young. I obtained an albino example which must have been forwarded to the Smithsonian Institution. Mr. Moberly writes:

This squirrel is common at every place I have been since I came to the company's service in 1854—on the North Saskatchewan, Peace, and Athabasca rivers, and at Frazer Lake, British Columbia.

There is another ground squirrel, smaller than the red, and more brownish in color, and lives high up on the mountains, chiefly beyond the tree limit. It has a peculiar call, more like a whistle than a chatter. In British Columbia there are three kinds of squirrels not found east of the Rockies. One has the head broader than the red squirrel with ears very round and with tufts on them; the color brownish, the whiskers quite black, as well as the tips of the tail. The other is smaller and has the tip of the tail black. I have only seen it close to the mountains. A third is a large ground squirrel, with a tail somewhat resembling that of a flying-squirrel, which may be a spermophile.

NORTHERN CHIPMUNK.

Eutamias quadrivittatus borealis (Allen).

Specimens of this chipmunk were collected at Salt River (an affluent of the Slave River below Fort Smith, Athabasca District), Forts Resolution and Rae, Great Slave Lake, Fort Liard, and one also by the writer, labelled "Mackenzie River," which was probably secured between Fort Good Hope and Fort Simpson. I never saw any in the Anderson region. Mr. Ross^a gives its range as extending to Fort Good Hope; and that these animals were very destructive to such garden produce as was raised at Fort Resolution. Dr. Frank Russell secured two examples at Grand Rapids near the outlet of the Saskatchewan River into Lake Winnipeg.

CHIPMUNK.

Callospermophilus sp.

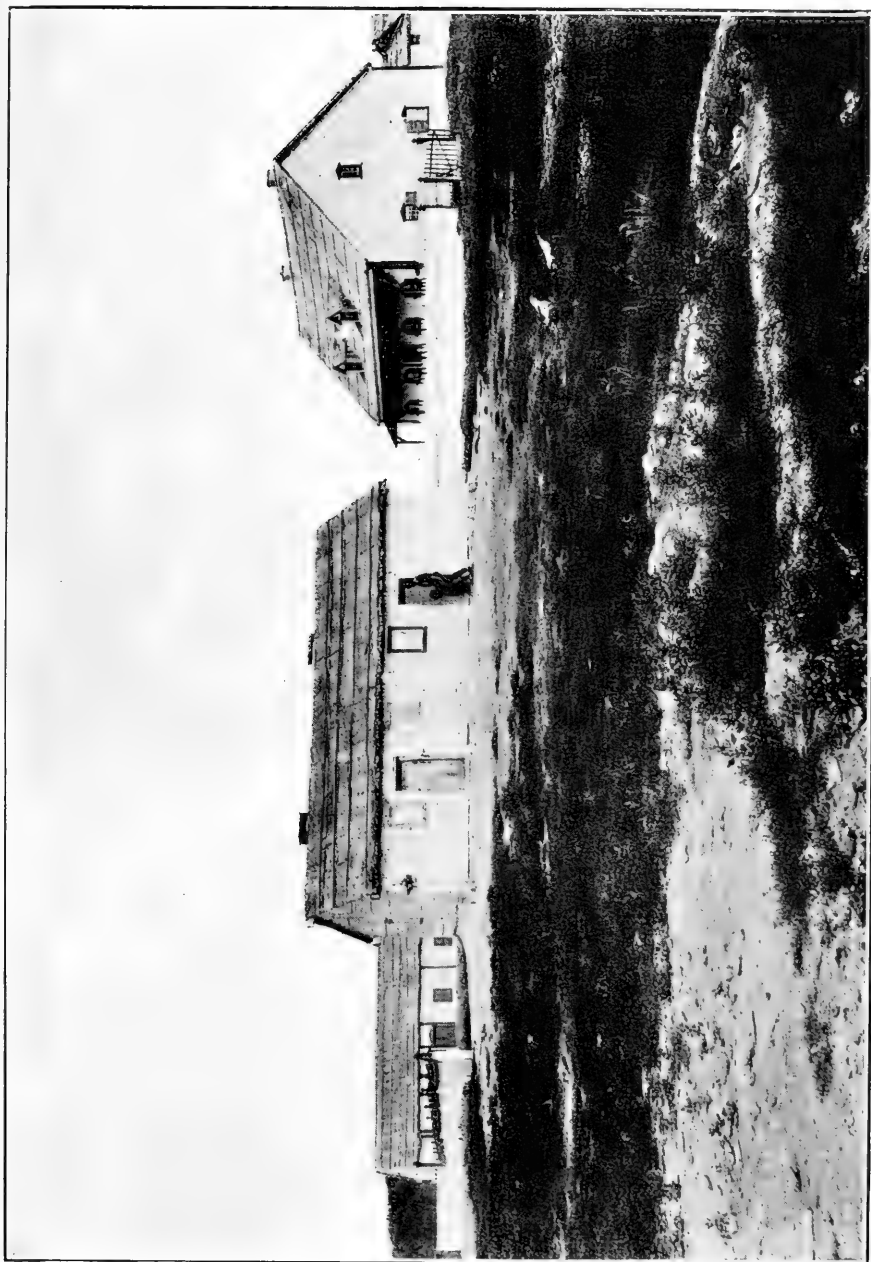
Mr. Drummond obtained examples of this species in the Rocky Mountains some seventy or more years ago, in about latitude 57° north. I can not say that I ever saw a specimen, neither did Mr. Preble on his recent collecting expeditions to Hudson Bay meet with or hear aught of this chipmunk.

PARRY'S SPERMOPHILE.

Citellus parryi (Richardson).

Abundant in the Barren Grounds, on the Arctic coast, and in the vicinity of many of the rivers and lakes of the North Country. In the early sixties of the last century, numerous specimens were obtained from Fort Anderson, the Barren Grounds, Liverpool and Franklin bays, from the Yukon, and from the Mackenzie River. They breed once a year and have several young at a birth. They live in burrows, as described by Mr. Preble, who secured specimens from a point 150 miles north of Fort Churchill. Doctor Russell also obtained three examples at Herschel Island, situated to the west of the outlet of the Mackenzie River.

^a Manuscript notes in the Smithsonian Institution.



FORT GOOD HOPE.



RICHARDSON'S SPERMOPHILE.

Citellus richardsoni (Sabine).

Richardson gives its range as not extending beyond latitude 55° north, and in the neighborhood of the north branch of the Saskatchewan River, but I do not think I ever met this animal anywhere in the country.

STRIPED SPERMOPHILE.

Citellus tridecemlineatus (Mitchill).

Richardson found this species quite common at Carlton House, Saskatchewan. It is also said to have been abundant in all favorable localities between the international boundary and the North Saskatchewan River. I do not think it is an inhabitant of the regions beyond that stream.

WOODCHUCK—GROUND HOG.

Marmota monax canadensis (Erxleben).

Mr. B. R. Ross gives latitude 62° north as the northern limit of this animal. In 1889, three trade skins were obtained at Fort Simpson. I do not remember if I ever saw any examples at Fort Anderson or elsewhere in the Mackenzie River District, but at Fort Chipewyan, Athabasca, several were observed, and in May, 1885, I sent five skins to Dr. R. Bell, of the Geological Survey, Ottawa. At Cumberland House, Saskatchewan, however, the company annually trade and export a few skins, which bring only a few cents in the London market. They are not common at any of the posts of the Pas, Moose Lake, and Grand Rapids. In 1888, one specimen was obtained at Pelican Narrows. The adjoining district of English River, to the north, traded 3 skins in 1889 and 127 in 1890. Of the last, 11 came from Isle à la Crosse, 2 from Portage La Loche, and 114 from Green Lake. It has also been met with on the Nelson, Liard, and Peace rivers, while Chief Trader Traill secured two examples at Fort St. James, Stuart Lake, British Columbia, which he duly forwarded to the Smithsonian Institution at Washington. The Cree Indian name of this animal is "weenuk."

HOARY MARMOT.

Marmota caligata (Eschscholtz).

This species is decidedly more abundant than *A. monax canadensis* in portions of the north country, especially in the neighborhood of the Rocky Mountains and spurs thereof on or near the Mackenzie River. Specimens have been collected on the Peace River, and at Forts Liard, Simpson, Norman, and Good Hope, Mackenzie River District, as well

as Fort Yukon and other points in Alaska; said to be common there beyond the Arctic Circle. In his list Mr. Ross writes: "North to Arctic Circle, abundant in the mountain ranges." For some unknown reason the company never export this fairly good fur pelt. The natives make excellent robes with the skins. I have seen several on the Mackenzie River. Mr. Turner states that the Indians of Kotzebue Sound, North Pacific, use many skins of these for clothing. In July, 1889, I obtained from a Connolly Lake (British Columbia) Indian a fine robe, which was forwarded to Washington.

INSECTIVORA.

SHREW.

Sorex sp.

Mr. Ross writes: "This genus (*Sorex*) is abundant throughout the district (Mackenzie River) as far north as the Arctic coast. I can not speak confidently of either the names or the number of the species." I have a strong impression that I have seen more than one kind of shrew at Fort Anderson, Mackenzie River, in Athabasca, at Stuart Lake, and at Cumberland House. A specimen in alcohol was forwarded from Fort St. James, Stuart Lake, British Columbia, which is entered under *Sorex* (*Microsorex*) *hoyi* Baird, in *North American Fauna*, No. 10, 1895, p. 90. Dr. Richard King has recorded a specimen of *S. forsteri*, which he found near the mouth of the Great Fish River.

COUES'S SHREW.

Sorex sphagnicola Coues.

The type-locality of this species is given in the above publication as Fort Liard, Mackenzie River District, and it probably extends much farther north. This shrew may be indigenous in other sections of the Canadian Northwest Territories. Mr. Moberly also refers to a small short-tailed mole or shrew with a sharp longish nose found only in beaver lodges.

CHIROPTERA.

SILVERY-HAIRED BAT.

Lasionycteris noctivagans (Le Conte).

Mr. Moberly states that he has seen examples of bats on the Peace, Saskatchewan, and Athabasca rivers. Mr. P. Deschambeault writes that he has met with this species, both at Isle à la Crosse and Lac du Brochêt, but I do not remember seeing any north of Cumberland House.

BLUNT-NOSED BAT.

Myotis lucifugus (Le Conte).

Mr. B. R. Ross, in his oft-referred-to list, mentions that this bat is very rare, but that it extends northward to Salt River. This species is entered among the specimens collected by Sir George Back on Great Slave Lake, probably near Fort Reliance, about seventy years ago. Mr. P. Deschambeault is also confident that it is sparingly present at Isle à la Crosse and Lac du Brochêt. Mr. Preble, however, did not come across any examples in his trip to the shores of Hudson Bay, while Dr. Robert Bell's list contains both species.

ADDENDA.

1.

In the third report of the select committee of the senate of the Dominion of Canada, appointed in 1888 to inquire into the resources of the "Great Mackenzie Basin," we find the following classified summary of one year's catch of furs offered for sale in London by C. M. Lampson & Co. and by the Hudson's Bay Company, namely:

Badgers.....	3, 739	Martens	98, 342
Bears of all kinds.....	15, 942	Minks	376, 223
Beaver	104, 279	Musk ox.....	198
Ermines	4, 116	Musquash.....	2, 485, 368
Fishers	7, 192	Extra black.....	13, 944
Foxes:		Otters, land.....	14, 439
Blue.....	1, 440	Rabbits.....	114, 824
Cross	6, 785	Sables	3, 517
Gray	31, 597	Seals, hair-dry	13, 478
Kitt	290	Skunks	682, 794
Red	85, 022	Swans	57
Silver	1, 967	Wolves	7, 156
White	10, 257	Wolverines	1, 581
Lynxes.....	14, 520		

It is to be regretted that the exact quantities of the foregoing furs and peltries pertaining to each of the companies were not given in separate columns, so that a naturalist, as well as the general public, might not form erroneous opinions in respect to the fur resources of the "Great Basin" in question. The annual fur sales of the Hudson's Bay Company in January and March comprise all of the pelts collected by their officers and agents throughout their former chartered and licensed territories and from parts of New Ontario, Quebec, and Labrador. On the other hand, while the Lampson incorporation undoubtedly received considerable quantities of the furs and peltries sold by them from the same hunting grounds, yet it is believed that the bulk of their entire yearly collection is obtained from Alaska and

other suitable sections of the United States of America. The Lampson's share of the foregoing summary statement would therefore be subject to the following estimated *outside of Canada* reductions: Many of the badgers, bears, beavers, ermines, fishers, blue and cross foxes, and all of the 31,597 gray, a large proportion of the silver and white, with upward of three-fifths of the red foxes, and many also of the white foxes, lynxes, and martens; fully three-fifths of the minks; more than two-thirds of the musquash; an important quota of the otters and rabbits; all of the 3,517 sables; some of the dry hair-seals; fourteen-fifteenths of the skunks, and a fair share of the wolves and wolverines.

We find 57 swan skins in the above summary, and they no doubt belonged to the Hudson's Bay Company. Although no skins of *Olor columbianus* or *O. buccinator* appear in their fur catalogues for 1897, 1900, 1902, or 1903, yet for many years they never failed in having quite a number of swan skins for sale in London. From 1853 to 1877 they sold a total of 17,671, or an average of nearly 707 skins a year. There were seven good years (1853 to 1856, 1861, 1862, and 1867), with sales ranging between 985 and 1,312 in 1854 (maximum), and seven poor years (1870 to 1877), with returns varying between 338 and the minimum (122) in 1877. From 1858 to 1884, inclusive, Athabasca District turned out 2,705 swan skins, nearly all of them from Fort Chipewyan. Mackenzie River District, according to a statement in my possession, supplied 2,500 skins from 1863 to 1883. From 1862 to 1877 Fort Resolution, Great Slave Lake, contributed 798 thereof. For 1889 Athabasca traded but 33, as against 251 skins in 1853. In 1889 and 1890 Isle à la Crosse, headquarters of English River District, sent out two skins for each outfit.

2.

The wording of a corporation's commission is almost unknown outside of the service, and the copying herein of the author's own last parchment may not therefore be considered out of place. His first as chief trader was dated 1868, under the deed poll of 1834; the next as factor under the deed poll of 1871 was granted in 1872, and the following in 1875. I may premise that the former recognized but two ranks, those of chief traders and chief factors, while the latter was four grades, namely, junior chief traders, chief traders, factors, and chief factors. Except in the title conferred, all of the commissions are exactly similar. The chief factor commission is as follows:

RODERICK MACFARLANE, Esquire:

By virtue of the charter granted by King Charles the Second by his letters patent under the great seal of England bearing date the second day of May in the twenty-second year of his reign to the governor and company of adventurers trading into Hudson's Bay. We do hereby appoint you a chief factor of the said company in all places where trade is carried on by the said company. You are therefore, in virtue of this commission, to exercise all the powers and to perform all the duties which now

are or hereafter may be exercised and performed by a chief factor, and particularly to observe all the provisions of the deed of regulations, under the common seal of the company, which bears date the nineteenth day of December, one thousand eight hundred and seventy-one, and we do hereby order and direct all our clerks and other servants strictly to obey such orders as you may think proper to give them in the execution of the duties of your office. And you are to observe and follow such orders, from time to time, as you shall receive from us, the governor, deputy governor, and committee of the company, or our successors for the time being, and all orders issued by our chief commissioner or resident governor.

Given under our common seal at our house in London, this first day of June, one thousand eight hundred and seventy-five.

By order of the governor, deputy governor, and committee.

[SEAL. ^a]

W. ARMIT, *Secretary*.

3.

Since the preamble to the foregoing notes was originally drafted, the writer has observed with great pleasure that Canada, by means of her capable and experienced officials, like the veteran Prof. John Macoun and son, Mr. William Ogilvie, the brothers Tyrrell, and others of the Dominion geological survey; by zealous missionaries like the Rev. Father Morice, O. M. I., of Stuart Lake, British Columbia, and the Rev. Mr. Stringer, C. M. S., formerly of Herschel Island, and now of White Horse, Yukon; and by other naturalists like the accomplished Mr. Ernest Thompson Seton, and Mr. Raine of Toronto, has already accomplished a good deal in the very desirable direction therein indicated. The lamented death of Dr. George Mercer Dawson, director-general of the Geological Survey, however, was a distinct loss to science and his country; but he has been fortunately succeeded by the clever and well informed Dr. Robert Bell, who will probably spare no possible efforts in continuing the good work performed by his able predecessors in office, Sir William Logan, Doctor Selwyn, and Doctor Dawson. I am also glad to see that American naturalists have again come forward to do their good share in the premises. Prof. C. C. Nutting, Doctor Smith and Dr. Frank Russell (especially the latter, who spent one winter at Grand Rapids, Saskatchewan, and another in the Mackenzie River District) have done much in furthering the interests of science and the State University of Iowa; while the brothers Preble of the U. S. Biological Survey at Washington have made an interesting summer journey to the shores of Hudson Bay; and they have also, in the spring of 1903, proceeded to Mackenzie River, where I think one or both of them should remain for two or three seasons (Kennicott was there from 1859 to 1862), and thereby render invaluable service in the elucidation of obscure points, as well as in collecting new material toward the ultimate completion of the natural history of con-

^a The seal consists of a coat of arms, with motto *Pro pelle cutem*, around which are the words "Hudson's Bay Company. Incorporated, 1670."

The original seal is entirely of a blue color and omits the words "Hudson's Bay Company. Incorporated, 1670."—R. McF.

tinental Arctic America. As to certain brief references herein to the great fur traders of the Northwest and Hudson's Bay Company of former days, as well as to some of the Arctic explorers, especially to those who have been engaged in the Franklin search, in which he has always felt a deep and abiding interest, the compiler believes that these digressions will be condoned by his readers, not only by the older for reminding them of the almost forgotten past, but by the younger, for calling their attention to the noble work accomplished by those who have gone before; and also for the reason that the successful collector and naturalist must necessarily be, more or less, imbued with an ambitious, enterprising, and persevering spirit, similar to that which, without doubt, actuated those men in their respectively able and heroic labors for science, Crown, and country.

For items of new or corroborative information used in the preparation of these notes, the undersigned feels much indebted and obliged to Chief Traders Henry J. Moberly, Pierre Deschambeault, William J. McLean; to Factor Alexander Milne, M. D.; to Chief Factor Archibald McDonald; and to Messrs. Colin Thomson, George Deschambeault, Murdo MacLeod, Henry MacKay, and Angus McLean of the Hudson's Bay Company.

Should this brief and far from perfect record of past achievements by those mentioned therein, have the effect of somewhat stimulating the innate ardor of some of the younger men of the company's service, *and others*, to make renewed and more systematic efforts than their predecessors, in the already referred to and much desired direction of obtaining and contributing material toward the completion of the natural history of the great Dominion of Canada, he will consider himself well repaid for the time, labor, and attention which he has here and formerly given to the interesting and important subject in question.

4.

Statement of fur returns for the Northern Department for outfit 1865.

District.	Badgers.	Bears.				Beavers.	Ermines.	Fishers.
		Black.	Brown.	Gray.	White.			
Mackenzie River.....	.....	462	27	19	6	8,490	.....	9
Athabasca.....	.....	306	39	10	.....	12,595	.....	46
English River.....	5	376	77	6	.....	3,669	.....	61
Cumberland.....	28	88	22	5	.....	3,244	.....	83
Saskatchewan.....	133	515	86	42	.....	11,954	.....	113
Swan River.....	165	120	87	20	.....	3,308	.....	46
Red River.....	310	333	107	11	.....	1,851	188	217
Lac La Pluie.....	.....	179	9	.....	.....	985	.....	322
Norway House.....	1	120	7	.....	.....	9,727	.....	393
York.....	.....	144	4	.....	3	12,551	55	106
Total.....	642	2,643	465	113	9	68,374	243	1,396

Statement of fur returns for the Northern Department for outfit 1865—Continued.

District.	Foxes.						Lynxes.	Martens.	Minks.
	Blue.	Cross.	Kitt.	Red.	Silver.	White.			
Mackenzie River	7	347	.....	445	76	{ 4) 999}	3,311	16,452	138
Athabasca .....	.....	426	.....	563	108	.....	3,511	3,917	423
English River .....	.....	102	28	129	33	8	4,495	4,076	3,002
Cumberland .....	.....	79	123	326	6	.....	1,643	2,330	2,057
Saskatchewan .....	.....	83	462	274	21	.....	4,185	2,714	380
Swan River .....	.....	148	1,126	2,600	4	.....	1,798	747	1,862
Red River .....	.....	217	2,698	3,886	6	.....	1,982	2,065	6,368
Lac La Pluie .....	.....	265	.....	604	58	.....	1,865	840	6,633
Norway House .....	.....	141	.....	182	37	.....	3,297	6,265	2,273
York	13	201	.....	292	64	1,598	964	7,251	5,412
Total	20	2,009	4,437	9,301	413	2,609	27,051	46,657	28,548

District.	Musquash.	Musk ox.	Otters.	Raccoons.	Squirrels.	Skunks.	Weasels.	Wolves.	Wolverines.
Mackenzie River	6,976	25	110	.....	.....	.....	.....	45	75
Athabasca	4,770	.....	184	.....	.....	.....	.....	27	48
English River	10,790	.....	615	.....	.....	.....	.....	50	44
Cumberland	18,000	.....	366	.....	.....	4	1	316	6
Saskatchewan	4,656	.....	180	.....	.....	10	.....	1,608	46
Swan River	4,154	.....	237	.....	.....	245	18	1,477	17
Red River	64,578	.....	442	47	.....	362	21	4,045	21
Lac La Pluie	27,192	.....	523	.....	.....	1,163	87	.....	3
Norway House	6,320	.....	1,018	.....	.....	2	31	.....	24
York	9,546	66	2,535	.....	1,415	4	20	128	37
Total	156,982	91	6,210	47	1,415	1,790	178	7,696	321

The foregoing fur statement was extracted from Archbishop Taché's Sketch of Northwestern America, 1868. It was furnished to him by Chief Factor William Maclavish, of Fort Garry, at that time the resident governor of the Hudson's Bay Company in Canada.

The other departments (western, southern, and Montreal) of the service contributed the quantities of furs and peltries lacking in this statement and the totals of same as sold in London. It may, however, be said that the company's trade year or outfit begins on June 1 and ends on May 31 following, so that the 1865 returns in question reached England in the fall of 1866, and were only disposed of in the months of January and March, 1867. Previous to the introduction of steam in Athabasca (1884) and Mackenzie River (1886), the trade of Fort Yukon (abandoned 1870) was two years later in getting to market; for instance, that of 1865 reached La Pierre House in the summer of 1866 and was conveyed by dog trains to Fort McPherson the following winter. In 1867 the returns were forwarded by York boat to Fort Simpson, and thence shipped in 1868 to London by way of Portage La Loche and York Factory, Hudson Bay, where they were duly sold in 1869. La Pierre House (abandoned 1891) and Fort McPherson returns occupied one year less in transit. Now, however, the entire trade of the Mackenzie River district gets to market as early as that of any other part of the Northwest Territories. In making esti-

mates or comparisons between one or more trade years or outfits, it would be well to remember these relative facts.

The immense northern department of the Hudson's Bay Company may be briefly described as comprising the country extending from the international boundary in latitude 49° north to the shores of the polar ocean in latitude 70° north, a distance of some 1,500 miles. Its longitudinal breadth ranges from 92° to 122° and 141° west, and may average between 1,100 and 1,200 miles. The trading posts and stations (many of them have since been abandoned, and others reorganized or newly established) were as follows:

MACKENZIE RIVER DISTRICT.

1. Fort Simpson (headquarters).
2. Fort Resolution.
3. Fort Rae.
4. Fort Liard.
5. Fort Nelson (reestablished 1865).
6. Fort Norman (Great Bear Lake).
7. Fort Good Hope.
8. Fort McPherson (Peel River).
9. Fort Yukon (Alaska).
10. La Pierre House.
11. Big Island.

ATHABASCA DISTRICT.

12. Fort Chipewyan (headquarters).
13. Fort Vermilion.
14. Fort Dunvegan.
15. Fort St. Johns.
16. Fond du Lac.
17. Salt River.

ENGLISH RIVER DISTRICT.

18. Isle à la Crosse (headquarters).
19. Portage La Loche.
20. Green Lake.
21. Cold Lake.
22. Rapid River (Stanley).
23. Reindeer Lake.

CUMBERLAND DISTRICT.

24. Cumberland House (headquarters).
25. Nepowin.
26. The Pas.
27. Moose Lake.
28. Chimawawin (Cedar Lake).
29. Grand Rapids (Saskatchewan River).

SASKATCHEWAN DISTRICT.

30. Fort Edmonton (headquarters).
31. Fort Victoria.
32. Fort Pitt.

SASKATCHEWAN DISTRICT—continued.

33. Fort Carlton.
34. Fort à la Corne.
35. Jasper House.
36. Rocky Mountain House.
37. Lac St. Anne.
38. Turtle Lake.
39. Buffalo Lake.
40. Whitefish Lake.
41. St. Albert.
42. St. Paul.
43. Lesser Slave Lake.

SWAN RIVER DISTRICT.

44. Fort Pelly (headquarters).
45. Fort Qu'Appelle.
46. Fort Ellice.
47. Thunder Hills.
48. Egg Lake.
49. Shoal River.
50. Duck Bay.
51. Water Hen River.
52. Fairford.
53. Manitoba House.

RED RIVER DISTRICT.

54. Fort Garry (headquarters).
55. Stone Fort (Lower Fort Garry).
56. Pembina.
57. White Horse Plains.
58. Portage La Prairie.
59. Souris River.
60. St. Laurent.
61. Oak Point.

LAC LA PLUIE DISTRICT.

62. Fort Alexander (headquarters).
63. Fort Frances.
64. Rat Portage.
65. Lac Seul.

LAC LA PLUIE DISTRICT—continued.

- 66. Hungry Hall.
- 67. Eagle's Nest.

NORWAY HOUSE DISTRICT.

- 68. Norway House (headquarters).
- 69. Split Lake.
- 70. Nelson River.
- 71. Beren's River.
- 72. Grand Rapid.

YORK DISTRICT.

- 73. York Factory (headquarters).
- 74. Fort Churchill.
- 75. Severn.
- 76. Oxford House.
- 77. God's Lake.
- 78. Front Lake.
- 79. Island Lake.
- 80. Jackson Bay.

5.

The statement of the company's London fur sales from 1853 to 1877, inclusive, so frequently quoted and referred to in these notes, was given to me many years ago by my old friend, the late Chief Factor Robert Campbell, F. R. G. S., the discoverer and explorer of the Upper Yukon, with its important tributaries, the Lewis, Pelly, and Stewart rivers.

Mr. Campbell was a man of great integrity of character, whose name comes close to the end in a long list of active and undaunted men who, from the days of Sir Alexander Mackenzie and the earlier times of the French Canadian and English explorers, traversed mountains, ascended rivers, and trod the then unknown wilds of North America. It would certainly be impossible to find their superiors, and not, proportionally, very many their peers in any service. From 1838 to 1848 Mr. Campbell made many remarkable explorations, the result of which, though scarcely appreciated at the time even by the company for which he worked, can never be forgotten in the history of northwestern Canada. He died in Manitoba in the month of April, 1892, aged 80 years.

This is neither the time nor the place for dilating on the great services rendered to Canada and the British Empire by her own splendid Northwest Company of Montreal, as well as by the United Companies, since 1821, but the writer must, however, be pardoned for making one or two out of numerous published references thereto. Bancroft, the American historian, writes that in his opinion:

Of all associations formed at any time or place for the purpose of obtaining the skins of fur-bearing animals, the Northwest Company of Montreal was the most daring, dashing, audacious, and ultimately successful. Its energy was only surpassed by the apathy of its great chartered rival, which had been in existence one hundred and thirteen years. Canada had been twenty years in British possession when it was organized, without assistance, privileges, or government favors, by a few Scottish Canadians for the better prosecution of a business with which they were all more or less familiar.

Simon Dawson, chief surveyor of the Hind Expedition of 1857-58, who had visited Forts Garry, Ellice, Swan River, and many other Hudson's Bay Company's posts, has put himself on record thus:

It is impossible not to admire the order and system which are everywhere observed in the management of the company's posts and trade. It is a vast system of economy, carried out with the utmost sagacity and foresight in all its details, and a system, too,

which seems to work equally well under circumstances widely different. In the back settlements of Canada, as on the stormy shores of Labrador, among the warring tribes of the plains, or in the frozen regions of the far north, it seems to be alike successful. An organization so perfect can only be traced to the agency of superior management, and I am of the opinion that the success of the United Companies is as much due to the high talent of the officers who have the direction of their affairs as to other circumstances to which it is more frequently attributed, and there can be no doubt that the same judgment, care, and economy, brought to bear on any pursuit would meet with a very marked measure of success.

In course of a speech delivered in Winnipeg in October, 1881, the Marquis of Lorne, then governor-general of Canada and now Duke of Argyll, said:

Let me advert for one moment to some of the causes which have enabled settlers in this vast northwest country to enjoy in such peace the fruits of their industry. Chief among these must be reckoned the policy of kindness and justice which was inaugurated by the Hudson's Bay Company in their treatment of the Indians. There is one of the causes in which a traders's association has upheld the maxim "Honesty is the best policy," even when you are dealing with savages. The wisdom and righteousness of their dealing on enlightened principles, which are fully followed out by their servants to-day, gave the cue to the Canadian government. The Dominion to-day, through her Indian officers and her mounted constabulary, is showing herself the inheritress of those traditions. She has been fortunate in organizing the mounted police force, a corps of whose services it would be impossible to speak too highly.

At the same place a few years earlier the late Marquis of Dufferin expressed himself as follows:

There is no doubt that a great deal of the good feeling existing among the red men and ourselves is due to the influence and interposition of that invaluable class of men, the half-breed settler and pioneer of Manitoba, who, combining, as they do, the hardihood, the endurance, and love of enterprise generated by the strain of Indian blood in their veins with the civilization, the institutions, and the intellectual power derived from their fathers, have preached the gospel of peace and good will and mutual respect with equally beneficent results to the Indian chieftain in his lodge and the British settler in his shanty. They have been the ambassadors between the East and the West, the interpreters of civilization, with its exigencies, to the dwellers on the prairie, as well as the exponents to the white men of the consideration justly due to the susceptibilities, the sensitive self-respect, the prejudices, the innate sense of justice of the Indian race. In fact, they have done for the colony what would otherwise have been left unaccomplished and have introduced between the white population and the red man a traditional feeling of amity and friendship which, but for them, it might have been impossible to establish. Nor can I pass by the humane, kindly, and considerate attention which has distinguished the Hudson's Bay Company in its dealings with the native population. But though giving credit to these fortunate influences among the causes that are conducing to produce and preserve the happy result, the place of honor must be adjudged to that honorable and generous policy which has been preserved by successive governments of Canada toward the Indian, which at this moment is being superintended and carried out by your present lieutenant-governor, under which the extinction of the Indian title upon liberal terms has invariably been recognized as a necessary preliminary to the occupation of a single square yard of native territory.

It is almost needless to mention that the presence and work of both Roman Catholic and Protestant missionaries in Red River (the former first appeared in 1818 and the latter in 1820), and elsewhere, have also been very important factors in the foregoing beneficial connection.

Gen. Sir William F. Butler, who had visited and sojourned for a brief time at many of the company's inland posts, thus wrote in 1873:

Wild, desolate, and remote are these isolated trading posts of the vast interior, yet it is difficult to describe the feelings with which one beholds them across some ice-bound lake or silent river as the dog trains wind slowly amidst the snow. Coming in from the wilderness, from the wrack of tempest and the bitter cold, wearied with long marches, foot-sore or frozen, one looks upon the wooden dwelling house as some place of rest and contentment. I doubt if it be possible to know more acute comfort, for its measure is exactly the measure of that other extremity of discomfort which excessive cold and hardship have carried with them. Nor does this feeling of home and contentment lose aught for want of a welcome at the threshold of the lonely resting place. Nothing is held too good for the wayfarer—the best bed and the best supper are his. He has perhaps brought letters or messages from long and absent friends, or he comes with news of the outside world; but be he the bearer of such things or only the chance carrier of his own fortunes, he is still a welcome visitor at the Hudson's Bay post.

Sir William further writes that—

In early days Fort Chipewyan, on Lake Athabasca, was an important center of the fur trade, and in later times it has been made the starting point of many of the exploratory parties to the northern coast. From old Fort Chipewyan Mackenzie set forth to explore the great northern river, and to the same place he returned when, first of all men north of the fortieth parallel, he had crossed in the summers of 1792-93 the American continent to the Pacific Ocean. It was from new Fort Chipewyan that Simpson set out to trace the coast line of the Arctic Ocean, and, earlier than either, it was from Fond du Lac, at the eastern end of Lake Athabasca, that Samuel Hearne wandered forth to reach the polar sea. At times Fort Chipewyan has been the scene of strange excitements. Men came from afar and pitched their tents awhile on these granite shores ere they struck deeper into the heart of the Great North. Mackenzie and Simpson, and Franklin, Buck, Richardson, King, and Rae rested here before piercing farther into unknown wilds, where they flew the red-cross flag o'er seas and isles upon whose shores no human foot had pressed a sand print. Chipewyan is emphatically a lonely spot in winter, but when the wanderer's eye meets the red flag, which we all know and love so well, flying above the clustered buildings in the cold north blast, it is on such occasions as this that he turns to it as the emblem of a home which distance has enshrined deeper in his heart. But "Eight hundred thousand pounds sterling sunk in the Arctic Sea," will exclaim my calculating friend behind the national counter; "nearly a million gone forever!" No, head cash keeper, you are wrong; that million of money will bear interest higher than all your little speculations in times not far remote in the misty future. In hours when life and honor lie at different sides of the "to do" or "not to do" men will go back to times when other men, battling with nature or with man, cast their vote on the side of honor, and by the white light thrown into the future from the great dead past they will read their roads where many paths commingle. To-day it is useful to recall these stray items of adventure from the past in which they lie buried. It has been said by some one that a nation can not be saved by a calculation—neither can she be made by one. *If to-day we are what we are it is because a thousand men in bygone times did not stop to count the cost.*

These, out of many available and interesting extracts, will now end with one from a former noted Winnipeg divine, the Rev. D. M. Gordon, D. D., now principal of the Kingston University, Canada:

Indeed it is difficult to discover what attractions many of the agents of the company find in their secluded and lonely life. Familiar, in many instances, in earlier days with comfortable and even luxurious homes, and able to procure positions in civilized life where a competence, if not a fortune, was assured, they have chosen instead a life that in many cases cuts them off for a large portion of the year from any intercourse with the outer world, or any companionship worthy the name, and from all or almost all that we are accustomed to regard as the advantages of civilization. When sickness comes they are dependent upon themselves or on their Indian neighbors. When their children grow up they must send them away to school, often at an expense which their incomes can not well afford. Their promotion comes slowly at the best, for it is a service in which men live long, and promotion may mean the charge of a post or district farther away from civilization, while the prospect of becoming a chief factor or of being able to retire with a competency is distant and shadowy. Many missionaries will undergo all this and even more than this, but they are supposed to be animated by a clear and lofty purpose that nerves them for exile and hardship if they can but fulfill their aim. Gold hunters will undergo much, but they, too, have a definite object; but the spell of the Hudson's Bay Company's service seems as vague and quite as powerful as that which binds the sailor to his seafaring life, which he may often abuse, but which he can not abandon. Its agents may be attracted by the freedom from the conventionalities and artificial restraints of society, by the authority which they enjoy over Indians and half-breeds, as well as by the scope for adventure and the opportunity for sport which most of them delight in. Ask them what fascination they find in it and they can hardly tell you. Listen to them when several of them are together "talking mousquash" (to use their own term for discussing the business of the company) and they have not many good words for the service; only when an outsider finds fault with it will they speak up strongly in its defense, and yet let them leave it for a time and many of them long to come back to it. One of them, a young Irish gentleman who had spent years in the service on the Upper Ottawa River and went home to Ireland, informed some of his Canadian friends that he found Dublin awfully dull after Temiscamingue. But, withal, among the officers of the Hudson's Bay Company you find men of education and refinement, competent to fill places of importance in society had they chosen the more settled walks of life.

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LIST OF PLATES.

PLATE XXX.

(Facing page 673.)

The Ramparts on Mackenzie River. The river here is only about one-third its usual width, but is 360 feet deep. It is forced between two great perpendicular stretches of sandstone rock, from 180 to 300 feet high, and continues so for about 1 mile, when it again widens out.

PLATE XXXI.

(Facing page 688.)

Fort McPherson, the most northerly post of the Hudson's Bay Company. It is on Peel River, within the Arctic Circle, 2,000 miles north of Edmonton. The mid-night sun shines here for about two weeks. The Eskimo frequently come as far south as McPherson to trade.

PLATE XXXII.

(Facing page 702.)

Hudson's Bay Company's post, Chipewyan, on Athabasca Lake, 500 miles north of Edmonton.

PLATE XXXIII.

(Facing page 734.)

Hislop and Nagle trading steamer, bringing their supplies into the post at Resolution, Great Slave Lake.

PLATE XXXIV.

(Facing page 750.)

Fort Good Hope, Hudson's Bay Company, on the Arctic Circle, Mackenzie River.

DESCRIPTION OF A NEW TOAD FROM CUBA.

By LEONHARD STEJNEGER,
Curator, Division of Reptiles and Batrachians.

Two species of toads, both belonging to the section of the genus *Bufo*, in which the skin of the head has become involved in the ossification of the skull, have long been known to occur in Cuba, namely, *B. peltocephalus*, which is a large and common species, and *B. empusus*, somewhat smaller and of more local distribution. Both are confined to the island (the former, at least, also inhabiting the Isle of Pines), with related, though not closely allied, species in Haiti, Porto Rico, and Central America.

The species here to be described belongs to an entirely different section of the genus, and the skin of the top of the head is not only not involved in the cranial ossification, but has not even a trace of the bony ridges so characteristic of most toads. It was collected by Messrs. William Palmer and J. A. Riley during their expedition to Cuba in 1900.

BUFO LONGINASUS, new species.

Diagnosis.—No cranial bony ridges; first finger shorter than second; toes nearly fully webbed; skin smooth, pustulous, but without asperities; snout conical, projecting, pointed, with the nostrils near the tip; parotoids enormous, their length almost equaling their distance from the groin.

Habitat.—Cuba.

Type.—Cat. No. 27419, U. S. N. M.; El Guama, Pinar del Rio, Cuba; William Palmer and J. A. Riley, collectors; March 9, 1900.

Description of type.—Adult male: Head and body depressed, nearly flat above; snout concave along median line, conical, projecting, pointed; nostrils near the tip of snout and close together; canthus rostralis rounded; interorbital width much greater than width of upper eyelid; tympanum indistinct, about half the diameter of the eye; first finger shorter than second, with a pad of dark brown nuptial asperities on top and side of basal portion; tips of finger and toes slightly

swollen; toes nearly fully webbed; subarticular tubercles well developed, double; inner metatarsal tubercle moderate, not prominent, outer conical; a tarsal fold, the distal end of which resembles the inner metatarsal tubercle; tibio-tarsal articulation of hind leg extended forward along the side of the body, reaches halfway between insertion of fore leg and tympanum; skin above smooth with irregular smooth, distinctly pitted pustules separated posteriorly and on sides by anastomosing furrows; parotoids enormous, their length almost equaling



FIG. 1.—*BUFO LONGINASUS*, NATURAL SIZE.



FIG. 2.—*BUFO LONGINASUS*, THROAT AND CHIN. $2 \times$ NATURAL SIZE.

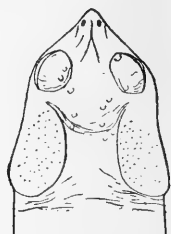


FIG. 3.—*BUFO LONGINASUS*, TOP OF HEAD AND PAROTIDS. $2 \times$ NATURAL SIZE.



FIG. 4.—*BUFO LONGINASUS*, HEAD FROM SIDE. $2 \times$ NATURAL SIZE.



FIG. 5.—*BUFO LONGINASUS*, RIGHT FOOT, UNDER SIDE. $2 \times$ NATURAL SIZE.



FIG. 6.—*BUFO LONGINASUS*, RIGHT HAND, UNDER SIDE. $2 \times$ NATURAL SIZE.

their distance from the groin, flat, descending on sides below the level of the tympanum, deeply pitted; throat longitudinally wrinkled on breast and belly, and underside of femurs coarsely granulated. Color (in alcohol) above, dark purplish maroon; underneath, including the upper lip, a narrow space above the insertion of the arm, and the internal half of the upper side of hands and feet white; a few dark purplish brown specks on lips, chest, and tibia and a longitudinal mark of the same color in front of insertion of fore legs.

Dimensions.

	mm.
Total length, tip of snout to vent.....	25.5
Width of head	9.5
From eye to posterior end of parotoid	7.5
Length of fore limb	13.0
Length of hind limb from vent to tip of longest toe.....	32.0

Remarks.—The type of this species is the only specimen brought home by the expedition, and as it has thus far escaped all earlier collectors in Cuba, it is apparently quite rare or very local in its distribution. The label indicates that it was captured in a mountain stream.

This new toad is so distinct in every way that it requires no comparison with any of the numerous species composing the genus *Bufo*. It has no relatives in the other Antilles or in North America.

LIST OF FISHES COLLECTED BY DR. BASHFORD DEAN ON THE ISLAND OF NEGROS, PHILIPPINES.

By DAVID STARR JORDAN and ALVIN SEALE,
Of Stanford University.

In the winter of 1900 and 1901 Dr. Bashford Dean visited the Philippine Archipelago. On the southern shore of the island of Negros he made a considerable collection of the small fishes of the reefs, this collection being sent by him to the United States National Museum. The present paper contains a list of the species (114 in all) obtained by Dr. Dean. Plates of the new species were prepared by Chloe Lesley Starks and William Sackston Atkinson, with one each by Mr. Robert L. Hudson, Miss Frances Lauderbach, and Mr. Sekko Shimada.

This collection shows that the fish fauna along the shores of the Philippines is essentially identical with that of the East Indies, most of the species being figured in Bleeker's Atlas. A few species belong to the fauna of India proper, and a few of the distinctive species of the South seas are included. The collection is especially rich in small fishes, the species usually overlooked by collectors. For this reason no doubt the number of new species is greater than would have been expected, and larger than a collection made in the market would show.

We are indebted to Dr. Charles H. Gilbert for material assistance in the comparison of specimens.

The following species seem to be new to science:

Eleria philippina.
Caranx (Citula) deani.
Amia gilberti.
Mionorus mydrus.
Foa fo.
Pomacentrus delurus.
Halicheres cymatogrammus.
Stethojulis zatima.
Sebastapistes nivifer.

Prosopodasys gogorzæ.
Butis leucurus.
Gnatholepis calliurus.
Drombus palackyi.
Glossogobius aglestes.
Salarias deani.
Salarias undecimalis.
Petroscirtes eretes.
Hypleurochilus toxias.

Family ELOPIDÆ.

MEGALOPS Lacépède.

1. MEGALOPS CYRINOIDES (Broussonet).

Four small examples less than 3 inches long were secured.

Anal rays, 27 or 28; the fin, 5 in length of body. Dorsal filament very short, its development probably a matter of age.

These specimens correspond to *Megalops macropterus* Bleeker, a species which is clearly the true *Megalops cyprinoides* of Broussonet, if indeed there be more than one valid species of *Megalops*.

Family CLUPEIDÆ.

HARENGULA Cuvier and Valenciennes.

2. HARENGULA MOLUCCENSIS (Bleeker).

One small specimen, apparently referable to this species.

3. HARENGULA SUNDAICA (Bleeker).

Four small specimens were secured.

Depth 3.25, in length, considerably more than length of head. Thickness of body, 3 in depth. A black spot at base of dorsal.

SARDINELLA Cuvier and Valenciennes.

4. SARDINELLA SIRM (Rüppell).

A small example with the scales strongly striate, apparently referable to this species. It has no trace of black spots along the back.

The three generic names *Sardinella*, *Sardinia*, and *Amblygaster* seem all to belong to the group of sardines. To this group the present species should be referred.

5. SARDINELLA CLUPEOIDES (Bleeker).

Two specimens, length, 2 inches. Scales not striate and not deciduous as in other sardines.

This species is the type of Bleeker's genus *Amblygaster*.

STOLEPHORUS Lacépède.

(*Spratelloides* BLEEKER.)

6. STOLEPHORUS JAPONICUS (Houttuyn).

(*Clupea argyrotenia* BLEEKER; *Spratelloides gracilis* SCHLEGEL.)

Two small specimens were secured.

Lateral band very distinct, but without dark streak above.

These specimens, corresponding to *S. argyrotænia*, seem to differ from Japanese examples only in having no distinct dark streak along the upper edge of the lateral band. Perhaps this may appear with age, as it is not conspicuous in the smallest of our Japanese examples.

Family ENGRAULIDÆ.

ANCHOVIA Jordan and Evermann.

(*Stolephorus* BLEEKER, not of LACÉPÈDE.)

7. ANCHOVIA COMMERSONIANA (Lacépède).

Numerous specimens of this species were secured.

Family DOROSOMATIDÆ.

ANODONTOSTOMA Bleeker.

8. ANODONTOSTOMA CHACUNDA (Hamilton Buchanan).

Numerous specimens of this species, representing the more elongate form, figured by Bleeker as var. *selangkai*, were taken.

The name *Anodontostoma* may be used for the species of *Dorosoma* which lack the dorsal filament. *Gonostoma* (Kuhl and Van Hasselt, 1822) was devised for the same group, but was earlier used by Rafinesque for a different genus.

The generic names *Clupanodon* Lacépède, *Thrissa* Rafinesque, and *Chatoëssus* Cuvier were all primarily based on a species from the West Indies confounded by Linnaeus with *Clupea thrissa*, the type of the latter called *Opisthonema* by Dr. Theodore Gill. For this American genus, and this only, the name *Clupanodon* should be used, and its type species should stand as *Clupanodon oglinus*. Lacépède's account of *Clupanodon thrissa* was based on the American and not on the Chinese species called *Clupea thrissa*. The Chinese species, originally named *Clupea thrissa* by Osbeck, must stand as *Konosirus thrissa* Linnaeus, the specific name *thrissa* having been taken by Linnaeus from Osbeck (1757). As Osbeck counted the fin rays D. 16, A. 24, *Konosirus thrissa* is no doubt identical with *Clupea nasus* Bloch (*Chatoëssus nasus* Cuvier and Valenciennes), the only species of the genus yet known from Hongkong and Canton. *Chatoëssus aquosus* Richardson, from Canton, is based on a dried skin of *Konosirus thrissa*, and there seems to be no trustworthy record of the Japanese species *Konosirus punctatus* (Schlegel) from China.

Family SYNODONTIDÆ.

SAURIDA Cuvier and Valenciennes.

9. SAURIDA BADI (Cuvier).

One specimen was secured. Eyes well veiled by the adipose membrane. Scales, 59. Snout rather blunt. This species seems to differ from *Saurida tumbil* (Bloch) in the large adipose eyelid and the absence of dark cross bands.

Family MYRIDÆ.

MURÆNICHTHYS Bleeker.

10. MURÆNICHTHYS MACROPTERUS Bleeker.

Two small specimens were secured.

Family MURÆNIDÆ.

GYMNOTHORAX Bloch.

11. GYMNOTHORAX PUNCTATO-FASCIATUS Bleeker.

Two specimens corresponding fairly to Bleeker's figure, one specimen darker and with slightly broader cross-bands than the other.

12. GYMNOTHORAX PICTUS (Ahl).

One specimen of this species was secured.

UROPTERYGIUS Rüppell.

13. UROPTERYGIUS CONCOLOR Rüppell.

Tail one-fifth longer than rest of the body. Color a uniform warm reddish brown.

A single small specimen was secured.

ECHIDNA Forster.

14. ECHIDNA NEBULOSA (Ahl).

One specimen of the common moray was secured.

15. ECHIDNA DELICATULA (Kaup).

Head and body anteriorly finely dotted with dark brown. General color brown. Bleeker's figure of *E. delicatula* represents this species fairly. That of *E. amblyodon* apparently represents a different species. *E. kishinouyei* Jordan and Snyder, from Okinawa, Riukiu Islands, seems to be identical with *E. delicatula*.

Family MORINGUIDÆ.

MORINGUA Gray.

16. MORINGUA LUMBRICOIDEA Richardson.

One specimen about a foot long, and one small example.

These differ from most of the species in having the jaws equal. Dorsal and anal fins traceable, depressed mesially; no pectorals. Head, 9 or 10 in length; depth, about 40. Anal beginning close behind the vent.

We hesitate to identify this species with *Aphthalmichthys lumbricoidea*, as our specimens have no trace of pectoral fin.

17. MORINGUA ABBREVIATA Bleeker.

One small example with no trace of fins except at the tip of the tail. Head, 10 in length; depth, 40. As the head becomes relatively shorter with age, this specimen is referable to *M. abbreviata* (head, 2 in length) rather than to *M. macrocephala*, in which the head is 9 in the total length.

Family BELONIDÆ.

TYLOSURUS Cocco.

18. TYLOSURUS GIGANTEUS (Schlegel).

(*Belone annulata* CUVIER and VALENCIENNES.)

Of the names *giganteus* and *annulatus*, of the same nominal date, 1846, *giganteus* is doubtless the older, occurring also on an earlier page in the volume.

One specimen of this widely distributed species.

Family SYNGNATHIDÆ.

GASTEROTOKEUS Heckel.

19. GASTEROTOKEUS BIACULEATUS Bloch.

Six fine specimens. According to Sherborn, the name *biaculeatus* of Bloch (1785) is prior to that of *tetragonus*, given by Thunberg in 1786.

HIPPOCAMPUS Linnæus.

20. HIPPOCAMPUS KUDA (Bleeker).

Two specimens, agreeing well with the account given by Jordan and Snyder.

Family ATHERINIDÆ.

ATHERINA Linnæus.

21. ATHERINA TEMMINCKI (Bleeker).

One example, agreeing fully with Bleeker's description.

Head, 4.50 in length; depth, 6.55, greatest breadth, 8; eye, 3 in head, snout 4.

D. VI-I, 8; A. I, 12. Scales, 42, two series above lateral stripe. Sides with a broad silvery band; upper parts dotted; pectorals pale.

Family SPHYRÆNIDÆ.

SYPHÆYNA Linnæus.

22. SPHYRÆNA JELLO Cuvier and Valenciennes.

Two young specimens.

Family CARANGIDÆ.

ELERIA Jordan and Seale, new genus.

A new genus, allied to *Scomberoides*, but with a strong diverging horizontal canine on each side of tip of lower jaw; outer teeth in both jaws strong.

The genus is named for the late R. P. Fra Casto de Elera, "Profesor de Amplificacion de Historia Natural," in the University of Santo Tomas de Manila, first local author to write on the fish fauna of the Philippines. Fra Elera's elaborate and painstaking work is entitled "Catologo Metodico de Toda la Fauna de Filipinas conocida hasta el presente, y a la vez de la coleccion del Museo de P. P. dominicos del Colegio Universidad de Santo Tomas de Manila."

23. ELERIA PHILIPPINA Jordan and Seale, new species.

Head, 4.15; depth, 3.10; eye, 4.10 in head; D. VII-I, 20; A. II-I, 18; lateral line slightly curved anteriorly; scales, about 200; snout, 3.50 in head; interorbital 3.50.

Body oblong, compressed; depth of caudal peduncle 4.50 in head; lower jaw large and prominent, but scarcely longer than upper when mouth is closed; maxillary narrow, its length 1.75 in head, its distal end under posterior third of eye; teeth on jaws, vomer, palatines, and tongue; lower jaw with 2 strong procurent diverging canines; upper jaw with 4 smaller diverging canines; outer teeth in both jaws enlarged; head naked; opercles entire, a slight median crest on top of head; a distinct spine directed forward at origin of dorsal; distance from tip of this spine to tip of snout, 3.12 in length of fish with-

out caudal, the longest spine, 2.75 in head; anterior dorsal ray, 1.85 in head; none of rays of dorsal or anal detached; anal with two anterior spines large and distinct from rest of fin; the second spine is the longest, 2.50 in head; pectorals short, 1.75 in head; ventrals, 2 in head; caudal well forked, its upper lobe, 1.10 in head.

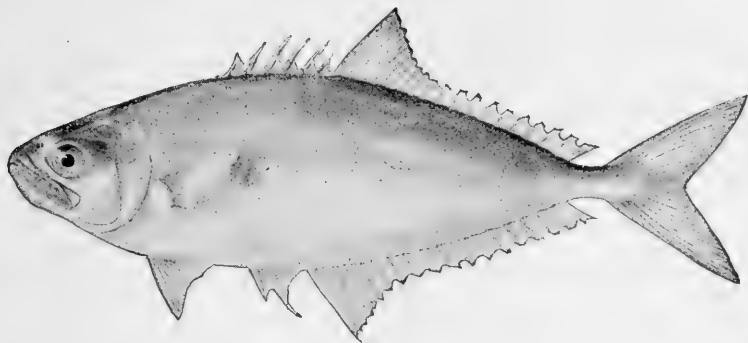


FIG. 1.—*ELÆRIA PHILIPPINA*.

Color in spirits silvery with a wash of bluish above; no spots or lines, except small black spot in axis of pectorals; fins uniform; an indistinct shade of darker blue at upper margin of opercles and above eye.

Four specimens from island of Negros.

Type.—Cat. No. 51945, U.S.N.M. Length, 4.75 inches.

CARANX Commerson.

24. *CARANX FORSTERI* (Cuvier and Valenciennes).

One specimen.

25. *CARANX DEANI* Jordan and Seale, new species.

Subgenus *Citula* CUVIER and VALENCIENNES.

Head, 3.14; depth, 2; eye, 4 in head; D. VI–I, 22; A. II–I, 18; scales very minute, about 54 in curved portion of lateral line and 44 developed scutes on the straight portion; snout, 3.10; interorbital, 4. Body oblong, compressed, the upper profile more evenly rounded than lower; depth of caudal peduncle equal to its width (including scutes), 5.20 in head; mouth moderate, the lower jaw scarcely longer than upper; maxillary extending to a line with anterior margin of pupil; teeth on jaws, vomer, palatines, and tongue; some of the anterior ones in lower jaw enlarged and canine-like; opercles entire; sides of head scaled; no scales on thorax; gill-rakers sharp pointed, slim, the longest two-thirds width of eye, 18 on lower limb; 2 or 3 small undeveloped spines in front of dorsal and anal, under the skin; adipose

eyelid very slightly developed; longest dorsal spine, 3.10 in head; the anterior rays of dorsal and anal greatly prolonged, being considerably longer than the head; none of dorsal or anal rays detached; base of soft dorsal, 2.25 in length of fish without caudal, its anterior ray, 2.50 in length of fish without caudal; anal spines very small and near

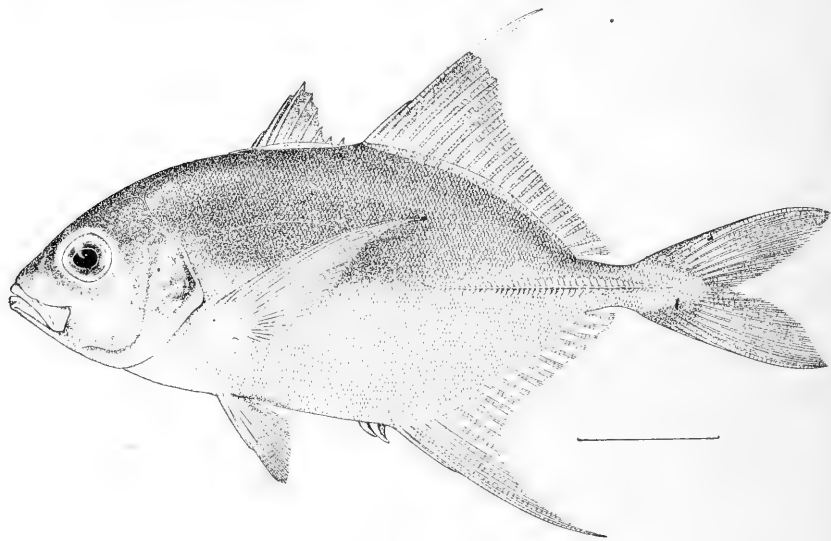


FIG. 2.—*CARANX DEANI*.

the fin; pectoral falcate, 2.85, in length, its tip reaching to the scutes; ventrals, 1.75; caudal deeply forked, about 3 in length.

Color in spirits dull silvery, with a slight wash of light brown above; soft dorsal and anal with slight tip of dusky; no opercular spot.

Two specimens.

Type.—Cat. No. 51951, U.S.N.M. Length, 6 inches.

26. *CARANX IRE* Cuvier and Valenciennes.

(*Caranx præustus* BENNETT.)

Two specimens. The black lobe of the dorsal in this species is very characteristic.

27. *CARANX HASSELTII* Cuvier and Valenciennes.

One specimen similar to others from Hawaii.

Family EQUULIDÆ.

LEIOGNATHUS Lacépède.

28. *LEIOGNATHUS SPLENDENS* Cuvier.

Five specimens.

29. *LEIOGNATHUS LEUCISUS* (Günther).

Three specimens, the dorsal spine a little shorter than indicated in Günther's description.

EQUULA Cuvier.30. *EQUULA INSIDIATOR* (Bloch).

One example.

GAZZA Cuvier and Valenciennes.31. *GAZZA MINUTA* (Bloch).

Seven examples.

Family *APOGONICHTHYIDÆ*.*AMIA* Gronow.

(*Apogon* Lacépède.)

32. *AMIA NOVEMFASCIATA* (Cuvier and Valenciennes).

One specimen, with the lateral bands forming connivent stripes on the caudal fin, as in Samoan examples.

33. *AMIA NOVÆ-GUINÆÆ* (Bleeker).

Two specimens, the one plain in color, the other crossed with faint pale bars.

34. *AMIA GILBERTI* Jordan and Seale, new species.

Head, 2.50; depth, 2.45; eye, 2.25 in head; D. VI-I, 9; A. II, 9; scales 2-24-6; lateral line complete; snout 1.75 in eye, 3.75 in head; interorbital 4 in head.

Body compressed, rather short and deep; depth of caudal peduncle 2.75 in head; tip of upper jaw on horizontal line with lower margin of pupil; mouth large; lower jaw slightly the longest; distal end of maxillary reaches to below anterior half of pupil; minute teeth in jaws, vomer and palatines; the posterior lower limb of preopercle is slightly denticulate, otherwise preopercles and opercles entire; gill-rakers slim and sharp pointed the longest equal to one-half of eye, 19 on lower limb; distance from origin of dorsal to tip of snout, 2.45 in length of fish without caudal; second dorsal spine rather elongate, 1.14 in head, base of soft dorsal, 2 in head, the longest ray, 1.90 in head; base of anal, 2.05 in head, the origin of anal is under anterior third of soft dorsal; pectorals, 1.30 in head, their tip below middle of soft dorsal; ventrals short, 2 in head, their tip not reaching base of anal; caudal probably rounded, but the fin is so broken as to render shape uncertain.

Color in spirits yellowish-white, a distinct black spot on middle of caudal peduncle at base of caudal; another distinct black spot on tip of opercles, just above and a little anterior to base of pectorals; some scattered minute black specks like pin-pricks on top of head, shoulders, and posterior of body; fins all yellowish-white, the dorsals with a

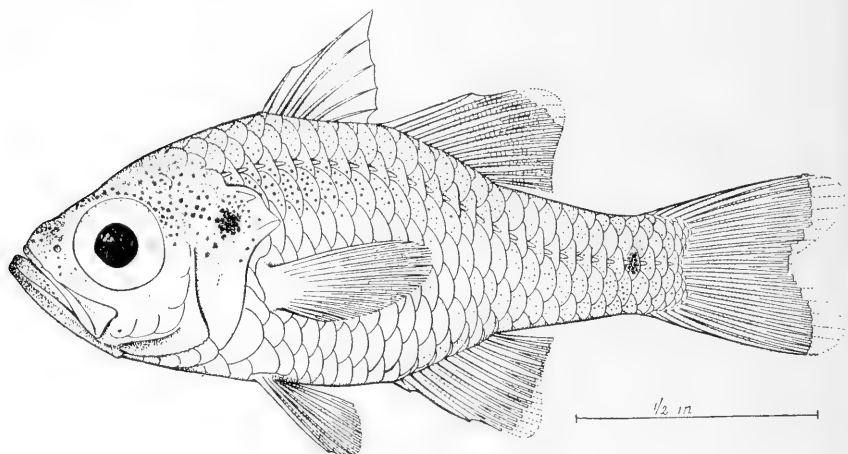


FIG. 3.—*AMIA GILBERTI*.

slight shading of minute black specks; tip of ventrals also slightly shaded with dusky; belly and cheeks rather brighter yellow, iris golden, darker above.

Three specimens from Negros, Philippine Islands.

Type.—Cat. No. 51941, U.S.N.M. Length, 1.65 inches.

Named for Prof. Charles Henry Gilbert, of Stanford University.

MIONORUS Krefft.

Preopercle entire; lateral line complete; teeth on palatines.

35. *MIONORUS MYDRUS* Jordan and Seale, new species.

Head, 2.50; depth, 2.75; eye, 2.50 in head; D. VI-I, 9; A. II, 8; scales, 2-24-7; lateral line complete; snout 4 in head; interorbital 3.01 in head.

Body compressed, rather short and deep; depth of caudal peduncle, 2.50 in head, 1.50, in its length; anterior of head evenly and dully pointed; gill-rakers sharp-pointed, less in length than eye, 12 on lower limb; small sharp-pointed teeth in jaws, vomer, and palatines; preopercle entire; opercle with a sharp point on margin, being the end of a short bony stay; distance from tip of snout to origin of dorsal 2 in length of fish without caudal; the second dorsal spine is longest, 2 in head; base of anal, 2.50 in head, its longest ray, 2.75; pectorals, 1.20 in head; ventrals reach to base of anal, their length, 1.30 in head.

In type specimen the fins are frayed and broken at ends so that it is

impossible to tell with certainty the shape of the caudal or its length. The caudal is, however, doubtless, rounded in life.

Color in spirits bluish-black; on anterior half of head the ground color seems to be yellowish covered with black dots or narrow reticulating lines, the black markings predominating and gradually hiding

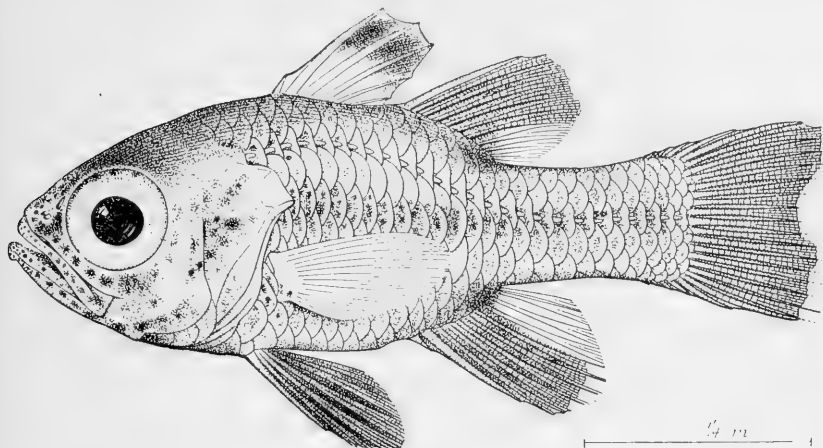


FIG. 4.—*MIONORUS MYDRUS*.

the yellow coloring on posterior half of head; fins are black, the three posterior rays of soft dorsal and anal are yellowish, base of pectoral yellow, the pectoral itself gray; iris golden.

One specimen Cat. No. 51946, U.S.N.M., from Negros. Length, 0.78 inch.

FOA Jordan and Evermann, new genus.

Preopercle entire; lateral line incomplete; teeth on palatines.

This genus contains small species allied to *Amia*, but with the preopercle entire and the lateral line incomplete. From *Apogonichthys* (= *Fowleria*; type *aurita*), *Foa* differs in the presence of teeth on the palatines, these being absent in *Apogonichthys*. *Mionorus* differs in having the lateral line complete. In *Amia* (*Apogon*) the posterior limb of the preopercle is serrate; in *Pristiapogon*, both limbs. *Fo* is the Samoan name for fishes of this family.

36. FOA FO Jordan and Seale, new species.

Head, 2.25; depth, 2.75; eye, 2.80 in head; D. VII-1-9; A. II, 8; scales 2-23-6, lateral line not complete; snout 4.85 in head; interorbital equal to snout.

Body compressed, of moderate depth, the dorsal outline much more convex than ventral, the greatest depth being at origin of dorsal fin; depth of caudal peduncle equal to orbit; head rather pointed, the lower jaw slightly the longer; mouth large; distal end of maxillary below posterior margin of orbit; minute teeth in jaws, vomer and

palatines; preopercle entire; gill-rakers very short, the longest equal to pupil, 7 on lower limb; distance from tip of snout to origin of dorsal, 2.12 in head; spines of dorsal not elongate, its longest spine, about 2 in head; longest rays of soft dorsal, 2 in head; base of anal, 3.75 in head, its longest ray, 2.50 in head; ventrals short, 2.25 in head; caudal probably rounded.

Color in spirits, yellowish-white, mottled with brownish, the mottlings assuming a more or less irregular band-like arrangement over back and sides; a dark stripe from lower posterior margin of orbit to

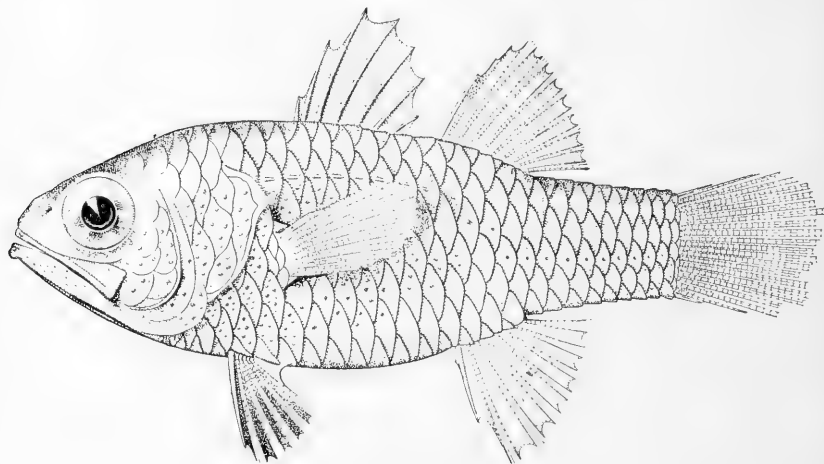


FIG. 5.—*FOA BRACHYGRAMMA*.

lower limb of preopercle; a dark band over posterior part of nuchal region; about 5 very indistinct darker bands around under part of head; spinous dorsal with two dusky blotches; soft dorsal yellowish; anal yellowish with about 5 indistinct brownish lines; ventrals with inner half and posterior part deep black; pectorals yellow; caudal yellow with four indistinct cross-bands of dusky; iris golden, darker above.

One specimen, $1\frac{1}{2}$ inches long, from Negros, Philippine Islands. We have also a specimen collected by Dr. George A. Lung, U. S. N., at Cavite.

Family PARAMBASSIDÆ.

PRIOPIS Kuhl and Van Hasselt.

37. PRIOPIS GYMNOCEPHALUS (Lacépède).

One specimen. The genus *Priopis* (Kuhl and Van Hasselt) may be defined as *Chanda* (*Ambassis*) with the lateral line interrupted. The name *Chanda* Hamilton-Buchanan (1822) has priority over *Ambassis* (1828).

Family SERRANIDÆ,

EPINEPHELUS Bloch

38. EPINEPHELUS TAUVINA (Forskål).

One large specimen.

CROMILEPTES Swainson.

39. CROMILEPTES ALTIVELIS Cuvier and Valenciennes.

One fine specimen.

PHAROPTERYX Rüppell.

(*Plesiops* CUVIER.)

40. PHAROPTERYX MELAS (Bleeker).

Three specimens, agreeing with specimens obtained by Jordan and Kellogg in Samoa.

Family PSEUDOCHROMIDÆ.

PSEUDOCHROMIS Müller and Troschel.

41. PSEUDOCHROMIS TAPEINOSOMUS (Bleeker).

One specimen, agreeing fairly with the description.

Family LUTIANIDÆ.

LUTIANUS Bloch.

42. LUTIANUS JOHNI Bloch.

One specimen.

43. LUTIANUS DECUSSATUS (Cuvier and Valenciennes).

One specimen.

NEMIPTERUS Swainson.

44. NEMIPTERUS ISACANTHUS (Bleeker).

One small example, the teeth less prominent than in Bleeker's figure.

Family HÆMULIDÆ.

TERAPON Cuvier.

45. TERAPON JARBUA (Forskål).

(*Terapon serrus* (BLOCH).)

One specimen.

SCOLOPSIS Cuvier.

46. SCOLOPSIS CILIATA (Lacépède).

One specimen.

Family SPARIDÆ.

LETHRINUS Cuvier.

47. LETHRINUS BONHAMENSIS (Günther).

Four specimens, agreeing with this species better than with *L. harak* or any other figured by Doctor Bleeker.

Family GERRIDÆ.

XYSTÆMA Jordan and Evermann.

48. XYSTÆMA PUNCTATUM (Cuvier and Valenciennes).

(*Gerres filamentosus* CUVIER and VALENCIENNES.)

Two specimens.

Family SILLAGINIDÆ.

SILLAGO Cuvier.

49. SILLAGO SIHAMA (Forskål).

Five examples. Dorsal unspotted.

Family MULLIDÆ.

PSEUDUPENEUS Bleeker.

50. PSEUDUPENEUS BARBERINUS (Bloch).

One specimen.

MULLOIDES Bleeker.

51. MULLOIDES AURIFLAMMA (Forskål).

Two specimens.

UPENEUS Cuvier.

52. UPENEUS TRAGULA (Bloch).

Several specimens.

Family OPHICEPHALIDÆ.

OPHICEPHALUS Bloch.

53. OPHICEPHALUS STRIATUS (Bloch).

One specimen.

Family ANABANTIDÆ.

ANABAS Cuvier.

54. ANABAS TESTUDINEUS (Bleeker).

One specimen from the stomach of an Iguana.

Family POMACENTRIDÆ.

POMACENTRUS Lacépède.

55. POMACENTRUS LIVIDUS (Forster).

Three specimens.

56. POMACENTRUS DELURUS Jordan and Seale, new species.

Head, 3; depth, 2.10; eye, 2.10 in head; D. XIII, 13; A. II, 13; scales, 2-18-9; snout, 3.75; interorbital, 3.50; preopercle strongly denticulate.

Body compressed, elevated; profile rather evenly rounded; depth of caudal peduncle, 2.35 in head; mouth small; teeth in a single series in each jaw; interorbital very narrow, about one-half as wide as pupil,

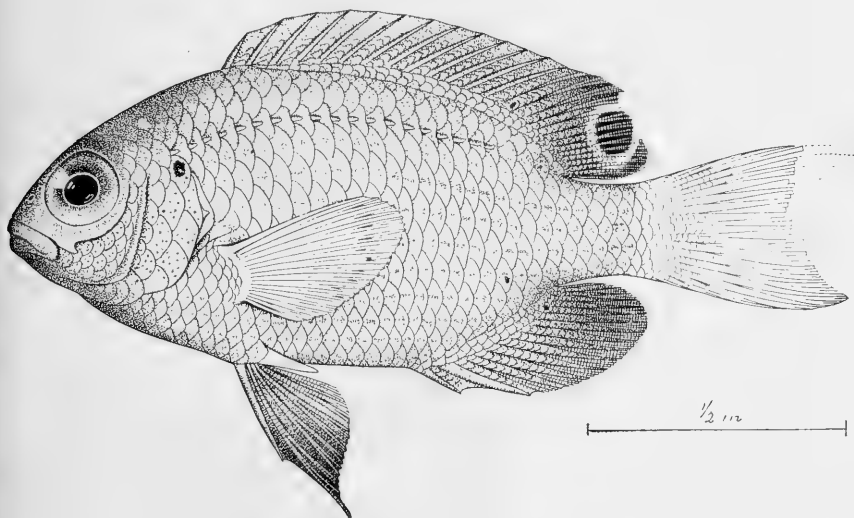


FIG. 6.—POMACENTRUS DELURUS.

the preorbital twice as wide as interorbital; angle of mouth is under the anterior margin of orbit; top of head covered with very small scales; dorsal spines graduated; the last spine not differing to any degree in length from the first ray; base of anal, 1.30 in head; pectorals about equal to length of head, the outer rays slightly filiform, bilobed, 1.12 in head.

Color in spirits dark brown; fins, except caudal and pectoral, blackish; the caudal is a bright yellow, the line of demarcation very abrupt and sharp at base of fin; a large blue-edged black ocellus on outer half of fifth to tenth rays of dorsal; a small black dot above opercle at origin of lateral line; no black dot at axis of pectoral or on upper part of caudal peduncle.

Two specimens from Negros, Philippine Islands.

Type.—Cat. No. 51, U.S.N.M. Length, 1.50 inches.

ABUDEFDUF Forskål.

57. ABUDEFDUF UNIMACULATUS (Cuvier and Valenciennes).

(*Glyphisodon dispar* GÜNTHER.)

Five specimens.

Family LABRIDÆ.

CHÆROPS Rüppell.

58. CHÆROPS SCHÆNLEINI (Agassiz).

One specimen, apparently identical with the original *Cossyphus schænleini* of Agassiz and Cuvier and Valenciennes from Celebes, but not the *Charops schænleini* of Bleeker.

Head, 3; depth, 2.50; eye, 6.75 in head; D. XIII, 7; A. III, 10; scales, 4-29-6, the tubule of each scale in lateral line with many branches, 7

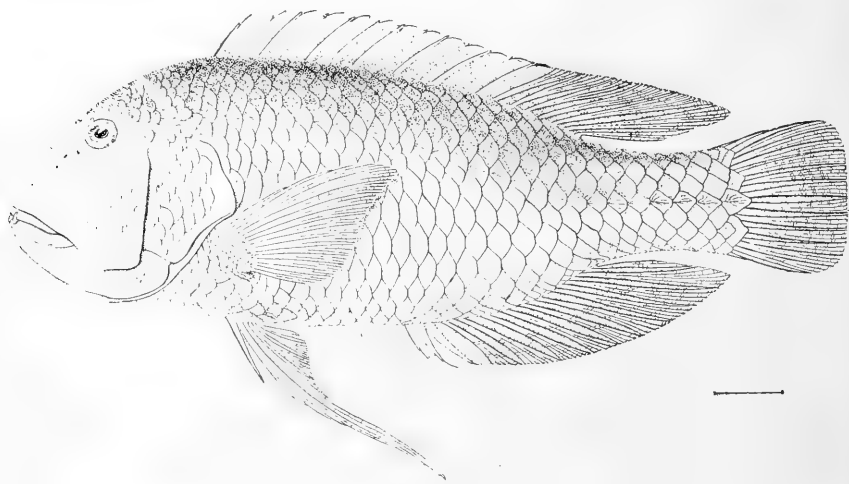


FIG. 7.—CHÆROPS SCHÆNLEINI.

rows of scales on cheeks; preopercle limb bare; snout, 2.10 in head; interorbital, 5 in head.

Body oblong, compressed; anterior profile of head rather abrupt, the snout having an angle of more than 45°; depth of caudal peduncle, 2.20 in head; mouth of moderate size, the angle is below the anterior nostril; teeth as usual in the genus, a posterior canine on each side of upper jaw, the four anterior canines in each jaw rather large; six rows of scales in front of dorsal with some additional rudimentary scales on nuchal region; the ventral fins and the posterior rays of dorsal and anal elongate; the posterior rays of dorsal reaching to caudal, the longest ray being, 1.30 in head; base of anal, 1.15 in head, about 2 in base of dorsal, its longest ray, 1.50 in head; ventrals greater than

length of head, 2.40 in length of fish without caudal, their tip extending to third ray of anal; caudal truncate, 1.30 in head.

Color in spirits dull yellowish-white; grayish on head, with distinct markings slightly darker on nuchal region, the fins distinctly and irregularly marked with brownish lines, some, especially on spinous dorsal and tip of caudal, taking the form of circles; ventrals unmarked; iris yellow; no black spot on dorsal.

One specimen in good condition. Length, 11.75 inches.

Two species of this genus are described by Cartier^a from young examples from Cebu. One of these, *Chærops meander*, has three white cross-bands on the body, which anastomose below, forming an irregular network. The other, *Chærops unimaculata*, has a large black spot on the last two spines of the dorsal fin. Both are based on specimens less than 3 inches long and scantily described. The scales in *C. meander* are 3-26 or 27-9, in *C. schænleini* 4-29-6. *C. meander* and *C. unimaculata* are both said to have no posterior canine. Without much doubt *Chærops meander* is the young of *Chærops anchorago*, while *Chærops unimaculata* must be the young of Bleeker's *Chærops schænleini*. Bleeker's figure resembles the Chinese species, *Chærops cyanostola* (Richardson) = *Chærops ommoptera* (Richardson), but it shows a large yellow spot behind and below the black dorsal spot. This is wanting in *C. cyanostola*. Probably Bleeker's species should stand as *C. unimaculata*.

HALICHÆRES Rüppell.

59. HALICHÆRES BINOTOPSIS Bleeker.

A dozen specimens were secured.

60. HALICHÆRES PSEUDOMINIATUS (Bleeker).

Two specimens were secured.

61. HALICHÆRES MINIATUS Bleeker.

A single specimen was secured.

62. HALICHÆRES PÆCILUS (Lay and Bennett).

(*Halichæres hartloffi* BLEEKER, *Halichæres annulatus* FOWLER.)

Head, 3; depth, 3.50; eye, 4.50 in head; D. IX, 11; A. III, 11; scales, 2-27-9; snout, 2.75 in head; interorbital, 4.50 in head; head naked; a posterior canine tooth.

Body compressed, oblong; anterior of head evenly pointed; depth of caudal peduncle, 2.30 in head; lips with folds; teeth, small canines, the anterior ones enlarged curved canines, a small posterior canine;

^a Verh. Phys. Med. Ges., Würzburg, V, 1873, p. 102.

ten rows of scales in front of dorsal fin; origin of dorsal directly above anterior axis of pectoral, longest dorsal ray, 3 in head; base of anal, 1.10 in head, 1.95 in base of dorsal, its longest ray, about 3 in head; pectorals, 1.60 in head; ventrals 1.90 in head; caudal rounded, 1.75 in head.

Color in spirits dull yellowish-white with slight bluish wash, a large blue blotch above the posterior of pectoral fin, which occupies more or less distinctly the upper anterior part of body, the posterior part of this blotch is indistinctly divided in three or four bands which descend to the ventral surface; three dark blotches along median line of posterior half of body; six dusky bands over back with narrow white lines between them, as in *H. opercularis*, these bands and lines obsolete in some specimens; nuchal region with 5-6 short longitudinal lines; a blue line from posterior margin of upper lip to eye. A deep-blue bar back of eye, from which a line of equal width and deep blue in color extends to origin of lateral line; lobe of opercle with a large deep-blue spot, the upper part of which is black; a wide curved blue line from upper posterior margin of preopercle, running down to lower posterior margin of opercle, a round circle of blue on cheek, either complete or in shape of a horseshoe (*hartloffii* or *pæcilus*), in one case (*annulatus*) complete on one side and not on the other; two blue lines on upper part of snout and three short longitudinal lines on interorbital; axis of pectorals bluish white; dorsal fin with large black spot on anterior rays, no spot between anterior spines, the base of soft dorsal with circles of light coloring and narrow tip of bluish; anal quite similar to that of *Halichæres dædalma*, (Jordan and Seale MS. from Samoa) a row of round spots at base of fin, a light line through center, the fin itself bluish. Caudal with some dusky ring-like spots; pectorals and ventrals uncolored.

Two specimens from Negros, Philippine Islands. Length, 2.75 inches.

63. *HALICHÆRES CYMATOGRAMMUS* Jordan and Seale, new species.

Head, 3; depth, 4.20; eye, 3.75 in head; D. IX, 10; A. III, 11; scales, 2-28-6; no scales on head or cheeks; snout, 3.52 in head; interorbital 5.10 in head.

Body compressed, oblong, the ventral surface almost straight, dorsal surface convex; depth of caudal peduncle, 2.75 in head; snout rather pointed; lips with folds; teeth small canines, the anterior ones in each jaw curved and somewhat projecting, a single small posterior canine at angle of jaws; origin of dorsal directly above axis of pectorals, its longest ray is, about 3.25 in head; base of anal is, 1.15 in head, 2 in base of dorsal, its longest ray, 3.50 in head; pectorals, 1.75 in head; ventrals, 2.50 in head; caudal rounded, 1.75 in head.

Color in spirits yellowish white, the belly and lower half of head bluish white; a distinct dark brown wavy stripe slightly wider than pupil from posterior margin of eye to base of caudal; a light brown stripe from origin of dorsal to interorbital, where it divides into two, which extend down to tip of snout; two short brown lines from upper

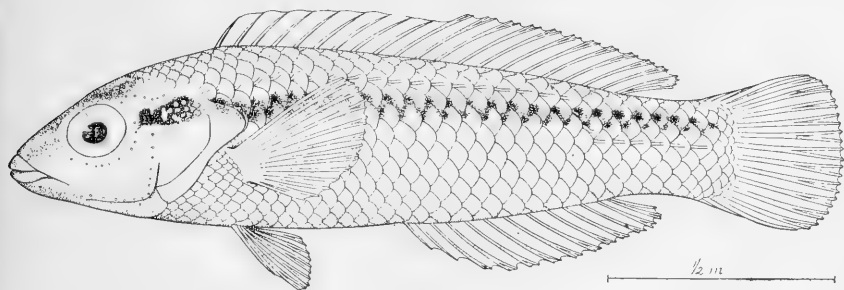


FIG. 8.—*HALICHÆRES CYMATOGRAMMUS*.

orbitals to back part of head; indistinct brown line from front of eye along sides of snout and around upper lip; a similar, but less distinct, line around lower lip; the tips of lips yellow. fins yellowish without markings; iris yellow.

One specimen from Negros, Philippine Islands.

Type.—Cat. No. 51947, U.S.N.M. Length, 1.80 inches.

64. *HALICHÆRES ARGUS* (Bennett).

Labrus guttatus BLOCH, Ichthyologia, 1791, pl. CCLXXXVII, fig. 2, (not of Gmelin 1789).

Julis argus BENNETT, Zool. Journal, III, p. 577, pl. XIII, fig. 7 (not *Labrus argus* Bloch and Schneider).

One fine specimen of this beautifully colored species.

STETHOJULIS Günther.

65. *STETHOJULIS PHEKADOPLEURA* (Bleeker).

One specimen, with a distinct spot at base of caudal, similar to Samoan examples, but a little deeper in body than Bleeker's figure of *phekadopleura*. Head, 3 in length; depth, 3.10.

66. *STETHOJULIS BANDANENSIS* Bleeker.

Two specimens.

67. *STETHOJULIS KALOSOMA* Bleeker.

One specimen.

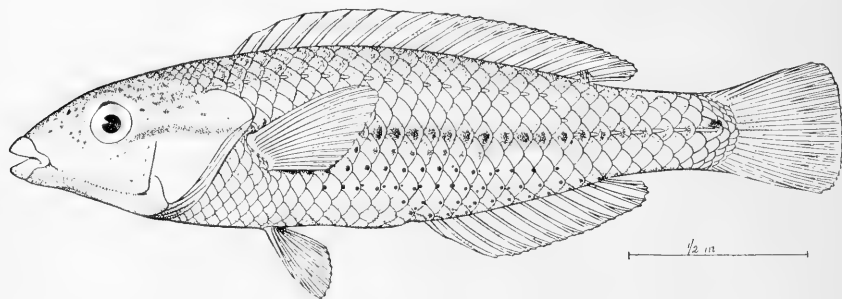
This species has the black line along sides almost obsolete; only a short dusky line from back of eye to about tip of pectorals; eye larger than in following species, being 4.50 in head, four lines of dots along lower sides, with some fine dark specks between them and with indistinct oblique lines.

68. *STETHOJULIS ZATIMA* Jordan and Seale, new species.

Head, 2.95; depth, 4; eye, 5 in head; D. IX, 11; A. III, 11; scales, 2-26-9; head naked; lateral line bent but continuous; snout, 3.10 in head; interorbital, 5.10.

Body oblong, compressed; depth of caudal peduncle, 3 in head; snout pointed, the jaws protractile; lips with folds; teeth small canines, the anterior ones somewhat enlarged, not extremely projecting; a small posterior canine at angle; origin of dorsal is directly above upper axis of pectorals, its longest ray is 2.75 in head; base of anal, 1.20 in head; 1.90, in base of dorsal; its longest ray, 3.50 in head; pectorals, 1.80 in head; ventrals, 2.75 in head; cauda rounded, 1.75 in head.

Color in spirits; light brown on upper half of body and head; yellowish white on lower half with five rows of brown dots on scales; no dots on belly proper; no fine specks between rows of dots; a distinct

FIG. 3.—*STETHOJULIS ZATIMA*.

brown band around snout and extending posteriorly to base of caudal; width of this band about equal to pupil; a black spot on caudal peduncle just above end of this band; a black spot between last two dorsal rays; dorsal fin with minute dark specks on its webs, all the other fins yellowish white; iris golden.

Two specimens from Negros, Philippine Islands.

Type.—Cat. No. 51943, U.S.N.M. Length, 2.35 inches.

This species is near *S. kalosoma*, but has a smaller eye, a distinct brown stripe the entire length of body; a black spot on caudal peduncle and on posterior dorsal, with dark specks on the fin, all of which *S. kalosoma* lacks.

NOVACULICHTHYS Bleeker.

69. *NOVACULICHTHYS KALLOSOMUS* (Bleeker).

One fine specimen, identical with others from Pago Pago and Honolulu.

70. *NOVACULICHTHYS MACROLEPIDOTUS* (Bloch).

One small specimen.

CHEILIO Lacépède.

71. CHEILIO INERMIS (Forskål).

One specimen.

Family SCARICHTHYIDÆ.

CALOTOMUS Gilbert.

72. CALOTOMUS MOLUCCENSIS (Bleeker).

One small example of this common species well marked by the black band across the pectoral.

73. CALOTOMUS VAIGIENSIS (Quoy and Gaimard).

(*Callyodon spinidens* CUVIER and VALENCIENNES.)

One small specimen.

CALLYODON Gronow.

(*Scarus* Forskål.)

74. CALLYODON MURICATUS (Cuvier and Valenciennes).

Two specimens.

Family EPHIPPIDÆ.

EPHIPPUS Cuvier.

75. EPHIPPUS ARGUS (Gmelin).

One specimen.

Family CHÆTODONTIDÆ.

PARACHÆTODON Bleeker.

76. PARACHÆTODON OCELLATUS (Cuvier and Valenciennes).

(*Chætodon oligacanthus* BLEEKER.)

One fine specimen.

Family SIGANIDÆ.

• SIGANUS Forskål.

77. SIGANUS CONCATENATUS (Cuvier and Valenciennes).

Two large specimens.

78. SIGANUS ORAMIN (Bloch and Schneider).

Six examples.

Family TRIACANTHIDÆ.

TRIACANTHUS Cuvier.

79. TRIACANTHUS STRIGILIFER Cantor.

One specimen apparently corresponding to this species, besides a very small one deeper in body, but probably of the same species.

Family MONACANTHIDÆ.

MONACANTHUS Cuvier.

80. MONACANTHUS CHINENSIS (Bloch).

One small example.

81. MONACANTHUS SUROTHURA Van Hasselt.

(*Monacanthus hajam* BLEEKER.)

Four specimens, corresponding to *Monacanthus hajam* of Bloch, a species apparently distinct from *Monacanthus tomentosus*. The manuscript name of Van Hasselt, *surothura*, published by Bleeker in an earlier paper, seems to claim priority over his own name *hajam*.

CANTHERINES Swainson.

82. CANTHERINES MACRURUS (Bloch).

One specimen. This species is the type of *Pseudomonacanthus*, a subgenus differing from *Cantherines* in the unarmed dorsal spine, a character apparently of less than generic importance.

Family OSTRACIIDÆ.

LACTORIA Jordan and Evermann.

83. LACTORIA CORNUTA (Linnæus).

One large example.

Family TETRAODONTIDÆ.

SPHEROIDES (Lacépède) Duméril.

84. SPHEROIDES LUNARIS (Bloch and Schneider).

Four examples.

TETRAODON Linnæus.

85. TETRAODON IMMACULATUS (Bloch and Schneider).

Five specimens, the smaller ones corresponding to *Tetraodon manillensis* Procé, with lengthwise lines of black above and below; these lines, obsolete on the larger example; caudal sharply edged with black.

86. *TETRAODON RETICULARIS* (Bloch and Schneider).

One specimen.

87. *SPHEROIDES OCELLATUS* (Osbeck).

Six small specimens apparently referable to this species, pale spots honey-comb like, hexagonal surrounded by blackish reticulations; a blackish bar across the back behind pectorals.

CANTHIGASTER Swainson.88. *CANTHIGASTER COMPRESSUS* (Procé).

(*Tetraodon striolatus* QUOY and GAIMARD.)

Two specimens. The name *compressus* is prior to that of *striolatus*, given by Quoy and Gaimard to this species.

Family SCORPÆNIDÆ.

SEBASTOPSIS Gill.89. *SEBASTOPSIS SCABRA* Ramsey and Ogilby.

One specimen.

SEBASTAPISTES Gill.90. *SEBASTAPISTES NIVIFER* Jordan and Seale, new species.

Head, 2.20; depth, 3; eye, 3.50 in head; D. XI, I, 10; A. III, 5; about 64 series of scales; interorbital in orbit; snout, 3 in head; a distinct fringed orbital tentacle about equal in length to width of eye.

Body compressed posteriorly, head large, spiny, naked, with some distinct skinny flaps; depth of caudal peduncle 4 in head; small teeth in jaws, vomer, and palatines; preorbital ends anteriorly in three spines the lower one of which extends downward and slightly directed backward over the maxillary; beneath this third spine is a large compound skinny flap; orbital and nuchal spines distinct, the orbital tentacle much more distinct than any of the spines; opercle has two distinct spines at posterior margin, these being the ends of two fan-like stays; the preopercle has five distinct spines at its posterior margin, the upper and largest one being opposite the posterior end of the bony stay of cheeks; the interorbital is rather narrow with two distinct ridges; gillrakers very short and thick, ten on lower limb; origin of dorsal is slightly in advance of origin of ventral, its longest spine, 2.10 in head, the eleventh dorsal spine is about one-half the length of the twelfth, the last ray of soft dorsal united by a membrane to caudal peduncle; base of anal, 2 in head; the second anal spine the longest, its tip, however, extending only to middle of fin, the length of the

spine being but little greater than orbit; pectorals, 1.50 in head; ventrals, 1.50 in head; caudal rounded, 1.50 in head.

Color in spirits grayish, mottled with light brown and whitish, a distinct white spot the size of eye on the posterior lobe of opercle; two distinct brown bands across interorbital space; two wide brown bands from lower margin of orbit, and an indistinct one from posterior margin of orbit; there are three short brown marks on each side of lower lip; also similar marks on premaxillary, but the throat and under part of

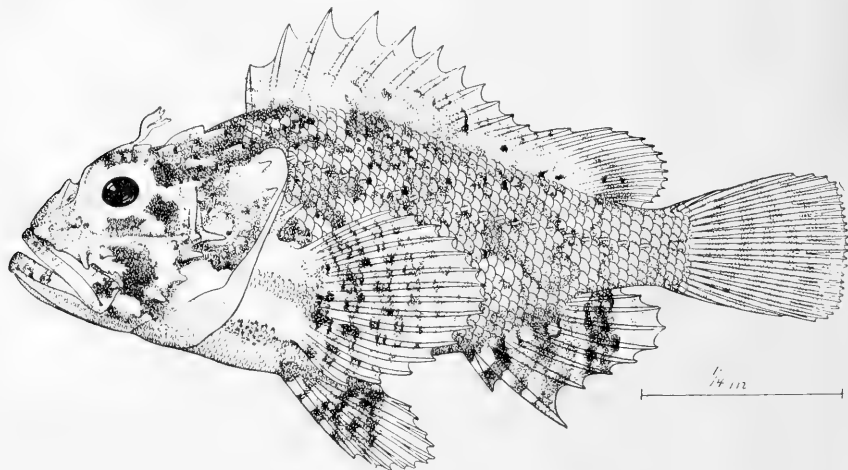


FIG. 10.—SEBASTAPISTES NIVIFER.

the head is unmarked; the dorsal fin is irregularly dotted with a few black and white spots; the posterior tip of the anal is gray, the middle is blotched with dusky; the spines have three dark bands across them; the pectoral is distinctly but irregularly banded by rows of black spots, with a few white spots intermixed; basal half of ventrals darker than posterior half; caudal gray, with slightly darker mottlings.

One specimen, Cat. No. 51954, U.S.N.M., from Negros, Philippine Islands. Length, 1.15 inches.

SCORPÆNOPSIS Bleeker.

91. SCORPÆNOPSIS NOVÆ-GUINÆÆ (Cuvier and Valenciennes).

One specimen.

PROSOPODASYNS Cantor.

92. PROSOPODASYNS GOGORZÆ Jordan and Seale, new species.

Head, 2.75; depth, 3; eye, 4 in head; D. III, X, 4; A. III, 4; interorbital equal to eye; snout, 4.

Body compressed; depth of caudal peduncle, 3.10 in head, preorbital ending anteriorly in 2 hooked spines; 2 spines at posterior margin of opercles; 4 spines on posterior margin of preopercle. The

upper one, which is also the longest, is situated at distal end of bony stay of cheek. Spines of the head not strongly developed; 3 or 4 small spines posterior of eye and 2 or 3 inwardly curved spines on nuchal region; scales on sides of head and body more or less rudimentary; small teeth on jaws vomer and palatines; mouth large, opening on dorsal profile; maxillary extending to below posterior margin of pupil; the first 3 spines of dorsal separate and situated on nuchal region directly above the opercle; distance between the two portions of the spinous dorsal about equal to eye. The last ray of the dorsal is attached by membrane to caudal peduncle. Base of anal, 1.50 in head; third spine of anal longest and strongest, its length, 1.50 in head; pectorals reaching to a line with origin of anal, its length equal to head; ventrals broadly attached to belly, their length, 1.50 in head; caudal rounded equal to head.

Color in spirits dull grayish, more or less marbled with pale brown;

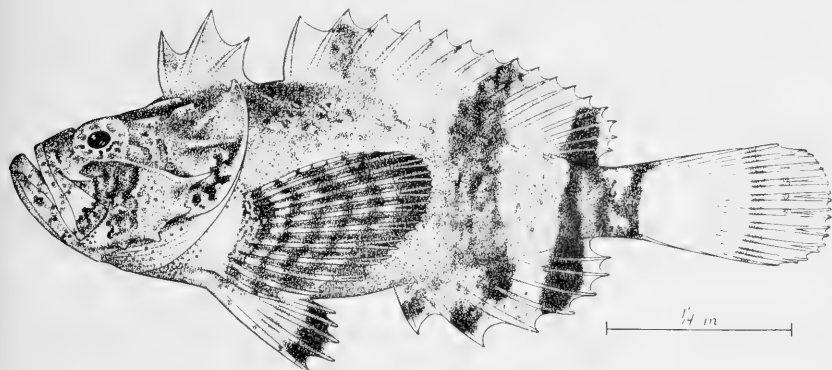


FIG. 11.—*PROSOPODASY'S GOGORZÆ*.

two rather distinct brown bands on posterior of body, the posterior one occupying the caudal peduncle; a rather indistinct irregular brown band across interorbital and from eye obliquely down cheeks; another irregular line near posterior margin of opercles; dorsal fin grayish, the black bands of the posterior part of the body extending into the fin; posterior third of anal fin dusky with white tip; the middle portion of the fin is white; the anterior portion gray; caudal with black line at base and two dark lines on its posterior third, otherwise fin white; pectorals dusky with irregular rows of black spots; ventrals black at tip, grayish anteriorly.

One specimen, Cat. No. 52054, U.S.N.M., from island of Negros, Philippine Islands. Length, 1.15 inches.

(Named for José Gogorza y Gonzalez, of Madrid, author of an excellent preliminary list of the vertebrate animals of the Philippines, 1888, entitled *Datos para la Fauna Filipina*.)

Family PLATYCEPHALIDÆ.

PLATYCEPHALUS Bloch.

93. PLATYCEPHALUS INSIDIATOR (Forskâl).

One large specimen.

Family GOBIIDÆ.

PERIOPHTHALMUS Bloch.

94. PERIOPHTHALMUS BARBARUS (Linnæus).

Numerous specimens.

SCARTELAOS Swainson.

(*Boleops* GILL.)

95. SCARTELAOS VIRIDIS (Buchanan-Hamilton).

One fine specimen.

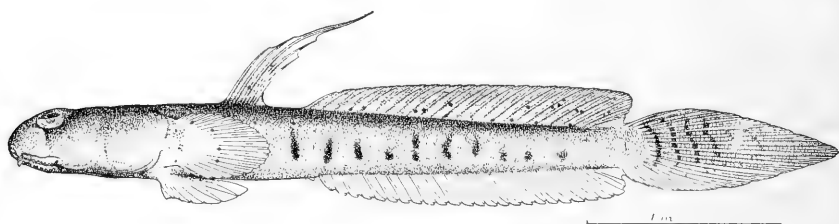


FIG. 12.—SCARTELAOS VIRIDIS.

VALENCIENNEA Bleeker.

96. VALENCIENNEA sp.

Four specimens, similar to others from Samoa.

HYPSELEOTRIS Günther.

97. HYPSELEOTRIS CYPRINOIDES Cuvier and Valenciennes.

Seven specimens, in good condition.

BUTIS Bleeker.

98. BUTIS LEUCURUS Jordan and Seale, new species.

Head, 3; depth, 5; eye, 5 in head; D. VI-9; A. 10; scales 29 from posterior margin of opercle to caudal; snout, 2.75 in head; interorbital 6 in head; tongue rounded; no posterior canines; head covered with minute scales; smooth bony ridges on head without serrations.

Body elongate, moderately compressed, the snout pointed and broad; lower jaw the longer; depth of caudal peduncle, 3.50 in head; mouth large, the angle under the anterior margin of orbit; bands of minute teeth in jaws, none on vomer or palatines; distance from tip of snout to origin of dorsal, 2.60 in length without caudal; longest dorsal spine, 3.20 in head, the rays slightly longer; base of anal, 2.10 in head; the longest ray, 3 in head; pectorals, 1.30 in head; ventrals, 1.75 in head; caudal rounded, 1.75 in head.

Color in spirits brownish with very indistinct brown longitudinal lines, lights on chin and belly, some small scattered black dots over body, 3 wide oblique brown lines on sides of head, the posterior one usually dividing into 2 on opercles; a brown line from anterior of orbit along sides of snout; 2 large irregular blotches on base of pectoral rays with a fine brown dot below each spot, top of snout slightly mottled with brownish lines; spinous dorsal gray with about 3 brownish bands; soft dorsal with some irregular dusky blotches; anal plain brown with white margins, caudal with very characteristic

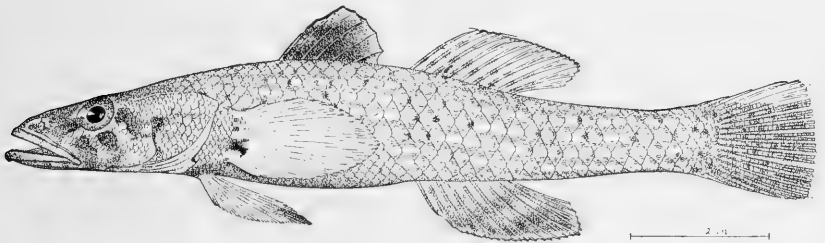


FIG. 13.—*BUTIS LEUCURUS*.

marking, having the 4 upper rays white, the remainder of the fin dusky with blackish vertical bands; pectorals yellowish white; ventrals yellowish white with indistinct brown cross-bands.

One specimen Cat. No. 51953, U.S.N.M., from Negros, Philippine Islands. Length, 3 inches. Several others of larger size and sharper markings with the pectoral spot very conspicuous have been received from Cavité from Surgeon George A. Lung, U. S. N.

This species, having no serrated crests on the head, may not be congeneric with *Butis butis*.

AMBLYGObIUS Bleeker.

99. *AMBLYGObIUS BYNOËNSIS* (Richardson).

One fine specimen agreeing well with Day's figure of this species.

100. *AMBLYGObIUS SPHINX* (Cuvier and Valenciennes).

One specimen of this strikingly marked species.

GOBIICHTHYS Klunzinger.

101. GOBIICHTHYS PAPUENSIS (Cuvier and Valenciennes).

Three specimens.

RHINOGOBIUS Gill.

(*Porogobius* BLEEKER; *Coryphopterus* GILL.)

102. RHINOGOBIUS CANINUS (Cuvier and Valenciennes).

One specimen.

ZONOGOBIOUS Bleeker.

103. ZONOGOBIOUS SEMIDOLIATUS (Cuvier and Valenciennes).

One specimen, similar to others from Samoa.

GNATHOLEPIS Bleeker.

104. GNATHOLEPIS DELTOIDES (Seale).

Head, 3.45; depth, 4.50; eye, 3.75 in head; D. VI-11; A. II, 10; scales 24 in series from posterior margin of opercle; cheeks and opercles scaled; tongue forked; snout, 3.50 in head; interorbital less than pupil.

Body moderately elongate, compressed; profile of head rather abruptly pointed, the upper jaw slightly the longer; depth of caudal peduncle, 2.20 in head; mouth small, with two series of small sharp-pointed teeth in each jaw; no posterior canines; angle of mouth is below anterior third of eye, distance from tip of snout to origin of dorsal is 2.75 in length of fish without caudal; longest rays of soft dorsal, 1.25 in head; base of anal, 3 in length of fish without caudal; pectorals, 3.10 in head; ventrals united equal to length of head; caudal distinctly pointed, equal in length to head.

Color in spirits grayish with seven dusky blotches on sides, alternating with dusky blotches over the back, a dark line down from eye around throat, another indistinct line separate from this on lower part of cheek and extending around chin, the two lines thus forming a greek letter delta on the under part of head, dorsal plain dusky or with indistinct darker lines; caudal with dusky bars, anal with dusky blotches; pectorals shaded with small dots.

Two specimens from Negros, Philippine Islands. These seem to agree fairly with our Samoan specimens.

105. GNATHOLEPIS CALLIURUS, Jordan and Seale, new species.

Head, 3 in length; depth, 4.75; eye, 4 in head; D. VI-11; A. 10; scales, 30; snout, 3.75; interorbital, 2 in pupil.

Body moderately elongate, compressed, anterior profile rounded, the lower jaw slightly the longer, the angle under the middle of the

eye; depth of caudal peduncle, 2.40 in head; minute sharp-pointed teeth in jaws, none on vomer or palatines; tongue rounded; opercles and preopercles entire; cheeks with three or four rows of large scales; opercles naked below, with about two series of large scales above; ten rows of scales in front of dorsal; longest spine, 2.10 in head; the longest ray, about 1.50 in head; base of anal, 2.10 in head; pectorals, 1.15 in head; ventrals united, 1.50 in head, the membrane of the cup very thin; caudal rounded, 1.50 in head.

Color in spirits light brownish, the margin of the scales darkest, a round black spot on middle line of caudal peduncle at base of caudal; four similar spots, but lighter in color, along the median line of sides; a dusky spot on opercles directly in front of pectorals; two other small spots on cheeks in front of this spot; a dark spot on lower posterior

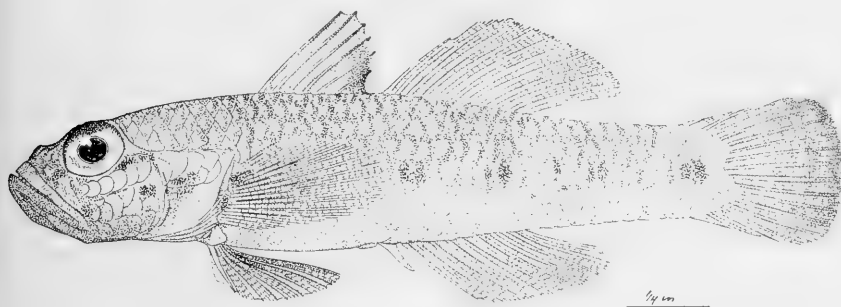


FIG. 14.—GNATHOLEPIS CALLIURUS.

margin of orbit; from this spot up and back along the upper margin of opercle is an indistinct dusky line; the dorsal fins are slightly shaded with dusky, almost black on posterior part of spinous dorsal; anal shaded with dusky; the middle of ventral shaded with dusky; caudal dusky with about six irregular lines of white; pectorals with dusky spot on upper and on lower base of fin.

Five specimens from Negros, Philippine Islands.

Type.—Cat. No. 51944, U.S.N.M. Length, 2.50 inches.

DROMBUS Jordan and Seale, new genus.

This genus differs from *Rhinogobius* in the presence of mucous channels bearing cross lines of minute cirri as in *Gobiomorphus*.

106. DROMBUS PALACKYI Jordan and Seale, new species.

Head, 3.10; depth, 6; eye, 3.75 in head; D. VI-11; A. 9; scales, 31 from posterior margin of opercle to base of caudal; snout, 4; interorbital about equal to pupil; tongue rounded.

Body moderately elongate, compressed; head bluntly pointed, the lower jaw slightly the longer; depth of caudal peduncle, 2.75 in head;

cheeks without scales but with numerous raised lines, probably mucous canals extending over cheeks, opercles, and nuchal region; minute teeth in jaws in several series, the outer row with the largest teeth; angle of jaw is below the anterior margin of eye; opercles and preopercles entire; distance from tip of snout to origin of dorsal, 2.50 in length of fish without caudal; longest dorsal spine, about 1.75 in head; longest dorsal ray, about 2.10 in head; base of anal, 1.75 in head, the origin of the fin equally distant from base of caudal and posterior

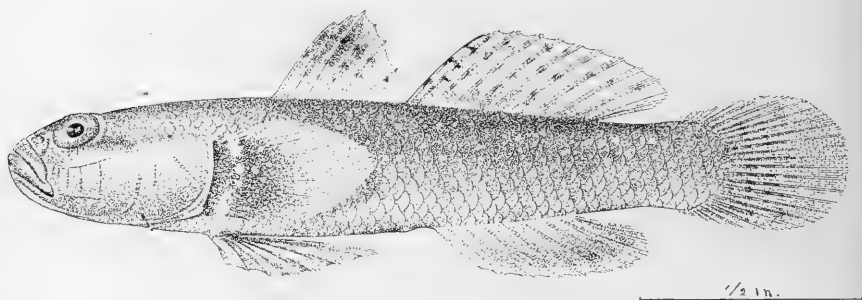


FIG. 15.—*DROMBUS PALACKYI*.

margin of preopercle; pectorals, 1.10 in head; no silky rays at upper part of pectorals; ventrals united, 1.30 in head; caudal, 1.30 in head.

Color in spirits brown, with indistinct whitish specks scattered over body; a dusky blotch on anterior third of pectorals, and with a whitish area on base and in axil of fin; dorsal fins dusky, the spinous dorsal with two or three darker blotches; anal, ventrals, and caudal dusky.

One specimen from Negros, Philippine Islands. Cat. No. 51954, U.S.N.M. Length, 1.85 inches. Named for Dr. J. Palacký, of Prag, author of *Die Verbreitung der Fische*, a work containing a list of the fishes of the Philippines.

GLOSSOGOBIOUS GILL.

107. *GLOSSOGOBIOUS AGLESTES* Jordan and Seale, new species.

Head, 3.10 (not including lower jaw), depth, 5.25; eye, 4.50 in head; interorbital about equal to pupil; snout, 3.50 in head; D. VI-11; A. 9; the last spine of spinous dorsal some distance from the others; lower jaw much produced, its length from posterior of angle 2 in head, its angle is below posterior margin of eye; scales, about 28.

Body elongate, cylindrical, largest at pectoral girdle; depth of caudal peduncle, 3.75 in head; mouth large, the lower jaw projecting; maxillary, 2.30 in head; two series of sharp, moveable teeth in each jaw, no teeth on vomer or palatines; tongue forked, its bony posterior two-thirds roughened; opercles and preopercles entire; gill-rakers scarcely developed; the eyes are very close together on the dorsal profile; scales on nuchal region are smaller than on other parts of the body; distance

from tip of snout to origin of spinous dorsal, 2.75 in length without caudal; longest dorsal spine about two in head, equal in length to longest dorsal ray; base of anal, 1.65 in head; pectoral, 1.45 in head; ventrals united, the membranous cup rather deep with its anterior margin notched; caudal rounded, 1.50 in head.

Color in spirits a dirty yellowish brown; the colors have almost disappeared in the type, but the species is easily characterized by the rather large white spots on under side of head and the markings of

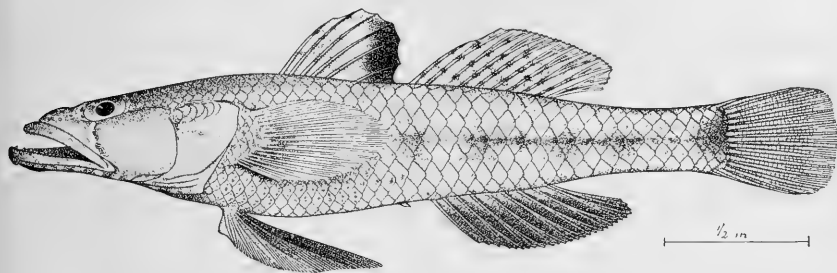


FIG. 16.—*GLOSSOGOBIUS AGLESTES*.

the fins, which are as follows: Spinous dorsal dusky with grayish on anterior base; soft dorsal grayish, more or less banded with dusky; caudal dusky with indistinct bars of lighter; anal and ventral dusky; pectorals gray with a short dusky bar on lower rays at base and two rather indistinct spots above; cheeks uniform brown.

One specimen from Negros, Philippine Islands. Cat. No. 51948, U.S.N.M. Length, 2.80 inches.

Family *BLENNIIDÆ*.

SALARIAS Cuvier.

108. *SALARIAS EDENTULUS* (Forster).

Four specimens.

109. *SALARIAS FASCIATUS* (Bloch).

Three specimens.

110. *SALARIAS DEANI* Jordan and Seale, new species.

Head, 4.10; depth, 5; eye, 3.10 in head. D. XIII, 19; A. 21; no canines; dorsal incised more than one-half its depth; lateral line short, ending under eighth dorsal spine; nasal tentacle double, unfringed; orbital tentacle simple, about as long as width of eye; no nuchal tentacle; head and forehead projected beyond the mouth, the angle of mouth being posterior of eye.

Body elongate, compressed; depth of caudal peduncle, 2.75 in head; teeth in a single series in each jaw; distance from front of head to origin of dorsal, 3.60 in length of body without caudal, longest dorsal

spine, 1.75 in head, longest dorsal ray about, 1.75 in head; posterior ray of dorsal is attached by membrane to base of caudal fin; base of anal fin, 2.50 in length of fish without caudal; the longest anal ray, 1.85 in head; pectorals slightly less than head; ventrals, 1.60 in head; caudal rounded equal to head.

Color in spirits gray, with more or less bluish wash; head apparently without markings; belly deep blue, about seven rather indistinct bands of darker color on sides, these seemingly made up of a double row of brownish spots more or less connected; the color-bands extend

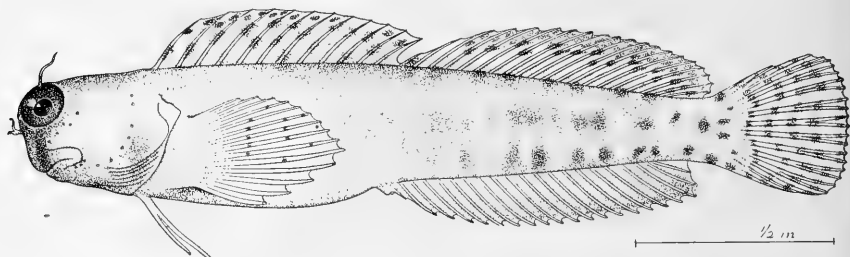


FIG. 17.—*SALARIAS DEANI*.

slightly into base of soft dorsal fin, and to top of fin in spinous dorsal; both dorsals have rather large blackish spots near the margin; caudal with six very distinct bands of blackish; anal white with dusky at margin; pectorals white with three rows of minute dots; ventrals white, uncolored.

One specimen. Length, 2.10 inches. Cat. No. 51950, U.S.N.M. From Negros, Philippine Islands.

III. *SALARIAS UNDECIMALIS* Jordan and Seale, new species.

Head from tip of opercle to most anterior point, 4.45; depth, 5; eye, 3 in head; D. XI, 17; A. 19; dorsal incised to one-half its depth; no posterior canine; lateral line extends to base of 10th dorsal spine.

Body elongate, compressed, the forehead and eye projecting beyond the mouth, the angle of mouth being slightly posterior to eye, a single unfringed tentacle at nostril, another similar, but longer somewhat greater than interorbital, over the eye, and a third short simple tentacle on nuchal region; no distinct crest; a single series of small teeth in each jaw; distance from forehead to origin of dorsal, 5.10 in length of fish without caudal, the longest dorsal spine, 2 in head, the longest ray, 1.50 in head, the posterior ray attached by membrane to base of caudal; base of anal, 2 in length of fish without caudal, the anterior rays the longest, about 1.25 in head; pectorals equal to length of head; ventrals, 1.50 in head; caudal equal to length of head.

Color in spirits dull grayish, with slight wash of pale green, sides of body banded with 12-14 double white bands, with numerous short violet lines and dots along the sides on and above the median line;

these are most abundant on anterior half of body where they almost obscure the white lines which are more or less broken up into white dots, a row of about 19 small black dots along the lateral fold; 8-9 black dots on caudal peduncle; cheeks covered with white dots which are more or less encircled with a purple ring, chin purplish; a brown ring of color at lower base of pectorals; belly uniform bluish gray; blotch of purple at anal opening; dorsal fin mottled with white and brown spots, the brown dots forming oblique lines on soft dorsal; anal

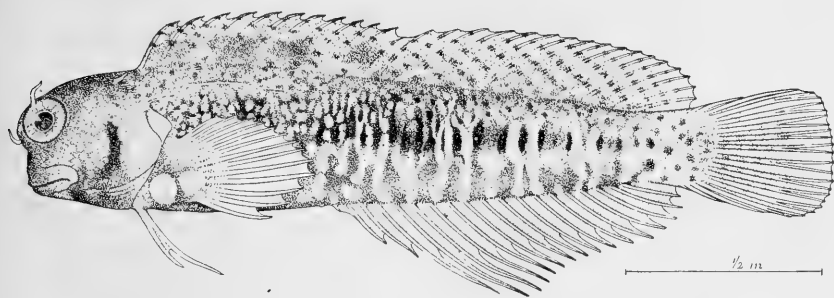


FIG. 18.—*SALARIA UNDECIMALIS*.

gray without markings except slight wash of dusky caudal with dark dots forming irregular lines, pectorals and ventrals white.

Four specimens, type is Cat. No. 51942, U.S.N.M. Length, 2 inches.

The smallest one of these four specimens, length 1.75 inches, lacks the purplish color of the type but is easily distinguished by the three sets of simple tentacles and the ring of brown on lower base of pectorals.

PETROSCIRTES Rüppell.

112. *PETROSCIRTES ERETES* Jordan and Seale, new species,

Head, 3.85; depth, 5.50; eye, 3.75 in head; interorbital, 4 in head; D. 30; A. 20; several dermal flaps about head, four on under jaw, one on upper part of each eye, a minute one on posterior part of superorbital, one on each side of nuchal region; with exception of the one on eye these are all small and easily overlooked. Young specimens show rather distinct papillæ at nostrils and on anterior interorbital region; four small papillæ on interorbital space.

Body elongate, compressed; upper profile of head evenly rounded; the upper slightly the longer; depth of caudal peduncle, 2.75 in head; teeth generic, about 20 on each side of upper jaw; angle of mouth under the anterior part of eye, 4.50 in length of fish without caudal; the origin of the dorsal being on nuchal region, slightly anterior to line with axis of ventrals; longest dorsal ray, 1.50 in head; base of anal, 2.75 in length of fish without caudal; origin of anal is midway

between pupil of eye and base of caudal fin; pectorals, 1.50 in head; ventrals, 1.50 in head; caudal, 1.10 in head.

Color in spirits yellowish, spotted and mottled with brown and dusky; the brownish markings showing as fine vertical bands over back and down sides usually very indistinct; the bands showing more distinctly in young specimens, becoming almost obscure in adults; under part of head, thorax, and belly yellowish white, a brown line around margin of lower lip; some indistinct short brown lines radiate from eye, the most distinct one being from posterior margin of orbit;

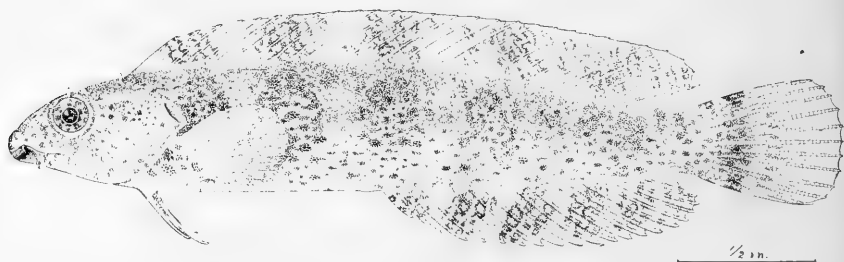


FIG. 19.—PETROCIERTES ERETES.

dorsal fin is grayish with numerous black blotches and dots; anal is whitish with about five dusky blotches made up of black dots; caudal white with dusky blotch at base; some very indistinct indications of brown cross-bands on rays of fin; pectorals and ventrals uncolored.

Six specimens from Negros, Philippine Islands.

Type.—Cat. No. 51949, U.S.N.M. Length, 3.10 inches.

HYPLEUROCHILUS Gill.

113. HYPLEUROCHILUS LOXIAS Jordan and Seale, new species.

Head, 4.25; depth, 6; eye, 2.75 in head; D. XII, 20; A. 20; snout, 5.10; interorbital about equal to pupil; no lateral line; dorsal not notched.

Body elongate, compressed, the anterior of head coming to a blunt rounded point; the mouth is small; the teeth, as in *Blennius*, a somewhat enlarged fang-like curved canine in upper jaw, none in lower jaw, otherwise the teeth consist of a single series in each jaw of rather long, round, curved, sharp teeth about 10 on each side of upper jaw and 7 on each side of lower jaw; opercles and preopercles entire; gill openings small; angle of mouth is under anterior margin of orbit, distance from origin of dorsal to tip of snout, 5.10 in length of fish without caudal, the last ray of dorsal connected by membrane to base of caudal, longest ray of dorsal, 1.85 in head; base of anal, 2 in length of fish, its origin slightly nearer tip of snout than base of caudal; pectorals equal to length of head; ventrals, 1.25 in head; caudal rounded, equal to length of head.

Color in spirits pale greenish white with 14 bluish oblique lines or spots on sides of body, the anterior ones most distinct, sloping obliquely down and back, the 6-7 lines are most vertical, the lines posterior of these slope exactly opposite to ones on anterior of body; over the back are about 12 bands of brownish, made up of double rows of indistinct spots; a large dusky spot on cheeks just posterior and below the eye; about 5 narrow dusky lines on sides of head and around under part of head; top of snout dusky; dorsal fin whitish without

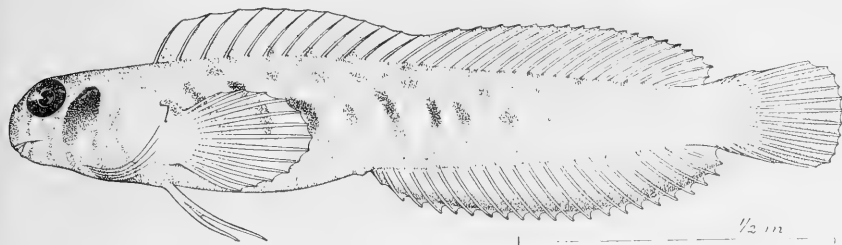


FIG. 20.—HYPLEUROCHILUS LOXIAS.

distinct markings; caudal white, the margin slightly shaded with dusky; anal white with dusky margin; pectorals and ventrals white, without markings.

One specimen, Cat. No. 51952, U.S.N.M., from Negros, Philippine Islands. Length, 1.20 inches.

Family PLEURONECTIDÆ.

114. SCÆOPS PÆCILURA (Bleeker).

One specimen. Gill-rakers very short and broad, scales large, deciduous. Caudal with a black spot near the margin above and below.



THE LIFE HISTORY OF THE SEA-HORSES (HIPPOCAMPIDS).

By THEODORE GILL,
Honorary Associate in Zoology.

In the ordinary works on fishes or natural history very little is said about the interesting little fishes popularly known as sea-horses. Many details, however, have been published in isolated notes or buried in general articles, which only one familiar with ichthyological literature would be likely to know about or even to find by using the current bibliographies. For the benefit of those interested in the group the notes here presented, brought together for a general work on fishes, are published.

I.

The sea-horses (Hippocampids) vary in form, but all are compressed and incapable of flexing the body sideways to any very considerable extent, the plates having extensions which are buttressed against cor-

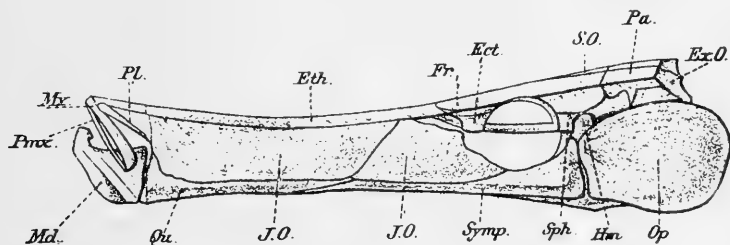


FIG. 1.—BROAD-NOSED PIPE-FISH (*SIPHONOSTOMA TYPHLE*). SKULL FROM SIDE SHOWING ELONGATION OF FACIAL BONES, SMALL MOUTH AND JAW BONES, AND ABSENCE OF PREOPERCLE. (AFTER SCHÄFF.) B. O., BASIOCCIPITAL; Ect., ECTETHMOID; Eth., ETHMOID; Ex. O., EXOCCIPITAL; Fr., FRONTAL; Hm., HYOMANDIBULAR; J. O., INFRAORBITAL; Md., MANDIBULAR; Me., MAXILLARY; Op., OPERCULUM; Pa., PARIETAL; Pl., PALATINE; Pmæ., PREMAXILLARY; Pt., PTEROTIC; Qu., QUADRATE; S. O., SUPRAOCCIPITAL; Sph., SPHENOTIC; Symp., SYMPLECTIC.

responding ones of the preceding and succeeding plates, thus prohibiting any decided lateral movements. The tail is more or less curved downward, and in typical forms highly prehensile; it is quadrangular in section.

The head in front of the eyes, or snout, is prolonged in a tubiform manner as in the pipe-fishes (*Syngnathidae*), and the mouth and jaws are small and at the end of the tube; the preopercle is absent and the operculum greatly enlarged.

While there is essential similarity in such characters, as to the cranium there is considerable dissimilarity between the pipe-fishes and the sea-horses as will be evident from the accompanying figures.

The best known of these fishes are the typical sea-horses, but other members of the family are much less aberrant from the pipe fishes, and indeed grade into them. There are in fact two distinct groups or subfamilies, the Hippocampines and Solegnathines. These differ in form and the form is determined partly by, or perhaps expresses, the development of ridges of the body.

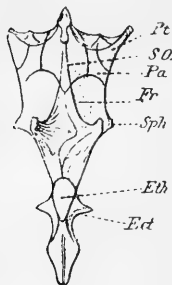


FIG. 2.—SEA-HORSE (*HIPPOCAMPUS RAMULOSUS*). SKULL FROM ABOVE. (AFTER SCHÄFF.) (For lettering see Fig. 1.)

The Hippocampines have the upper ridge of the caudal region terminated forward under the dorsal fin, and the lower caudal ridge continuous with the lateral ridge of the trunk; the nuchal plate is more or less elevated, crowns the back of the head, and is connate with the preceding plate.

Two typical and nearly related genera (*Hippocampus* and *Acentronura*) show these characters in perfection; three others (*Phyllopteryx*, *Halichthys*, and *Phycodurus*) share them in different degrees.

The typical sea-horses (*Hippocampus*) have the trunk compressed and relatively deep backward, the occipital region is surmounted by a sort of "coronet," and the tail is robust and rolled inward. The mature males have a pouch under the fore part of the tail with a small opening or slit in front.

The likeness to the conventional knight of the chessboard is much more marked than to a horse's head; indeed, if a spirula-shell or coiled worm were attached to the base of a chess knight the sea-horse would be well imitated. The ancient name *Hippocampus* is therefore very apt, being derived from the Greek *hippos*, horse, and *kampe*, worm or caterpillar. But let no one be deceived by superficial resemblance of parts. The head of the fish and that of a horse are essentially homologous, but here real likeness ends; the contracted part of the sea-horse does not correspond to the neck of a true horse, but to the fore part of the abdomen, there being no true neck in the fish; the lower part of the "neck" of the fish is really the hinder part of the abdomen, and the anus marks its hinder boundary.

The peculiar modification of the finless tail deprives it of its locomo-

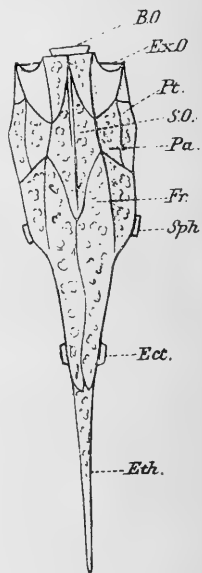


FIG. 3.—BROAD-NOSED PIPE-FISH (*SIPHONOSTOMA TYPHLE*). SKULL FROM ABOVE SHOWING DIFFERENCES FROM SEA-HORSE. (AFTER SCHÄFF.) (For lettering see Fig. 1.)

tor faculty, but a new function—prehension—results from its power to curl inward, and, to some extent, sideways.

The species are numerous, and one or more may be found in almost every tropical and temperate sea. Somewhere near three dozen species have been described, and of these one (*Hippocampus hippocampus* or *antiquorum*) is a common European fish, and half a dozen are inhabitants of north or middle American seas. One of them (*Hippocampus hudsonius*) extends northward in the Atlantic as far as Cape Cod, and another (*Hippocampus ingens*), one of the largest of the genus, in the Pacific to San Diego.

Strongly marked and bizarre as is the form, the fishes nevertheless are not conspicuous in the midst of their natural surroundings, and indeed the little animals appear to be able to readily adapt themselves to their environment. Kent (1883) tells that "some very extraordinary colored specimens" of the common Mediterranean species (*Hippocampus hippocampus*) were given to him; some were "bright red, others pale pink, bright or light yellow, and even almost pure white, with many other interblending shades. Such colors had apparently been assumed by the fish in keeping with and as a means of concealment among the brilliant vegetation and zoophytic growth indigenous to the locality from whence they were derived. These tints in confinement gradually disappeared, until the fish had assumed the normal light-brown or speckled hue by which they are generally characterized."

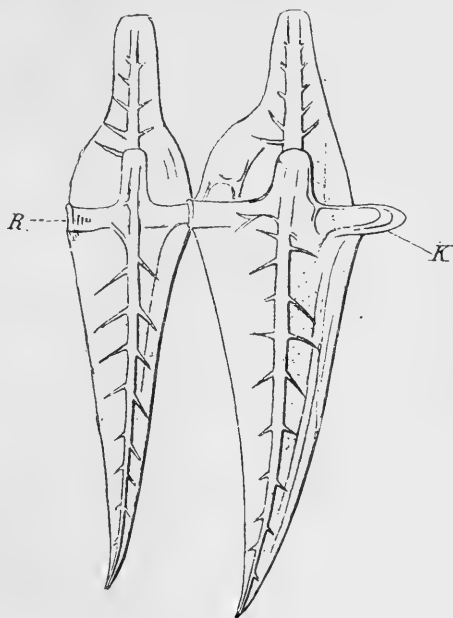


FIG. 4.—SEA-HORSE (*HIPPOCAMPUS RAMULOSUS*). TWO MIDDLE SIDE-SHIELDS SHOWING MANNER OF INTERLOCKING BUTTRESSES (K. R.). (AFTER SCHÄFF.)

II.

The attitudes and movements of the sea horses are eminently characteristic. The most frequent is a state of rest, with the tail wound around the stem of a plant or some other substance and the body is then carried nearly or quite erect. Such is the most frequent position, but notwithstanding the apparent rigidity of the cuirass, almost every other attitude consistent with such a form may be assumed. The

body may be thrown outward at various angles and even downward and the tail wound around a plant in a double coil. Once in a while one eye may roll toward you, while another may be passive or look backward or in an opposite direction. It becomes obvious that the little fish can move its eyes independently of each other and in entirely different ways.

A comical effect is produced by the way in which the little fishes peer at some object, reminding one of the actions of a very near-sighted person.

Releasing itself at length from its support, one may slowly progress, still in a vertical position, its tail curved inward, its dorsal fin rapidly undulating and reminding one of a screw propeller, its pectorals vibrating in harmony. The rapidity of the undulatory or vibratory movements of the dorsal and pectorals is especially noteworthy.

Incaised as it is in an almost inflexible coat of mail, progression can not be effected by lateral flexion of the body as in ordinary fishes, and flexion in a vertical direction is limited.

With such limited powers of progression, a nice adjustment of organs is called for, and Dufossé has explained one method. The air bladder is comparatively large and always distended by a quantity of gas so exactly in harmony with the specific gravity of the body that this entire body is a hydrostatic apparatus of extreme sensibility. A proof of this is that if a single bubble of gas no larger than the head of a very small pin be extracted, the fish immediately loses its equilibrium and falls to the ground, on which it must crawl till its wound has been cicatrized and a new supply of gas secreted by the internal membrane of the bladder.

III.

Another noteworthy peculiarity is a faint sound which is sometimes evoked. Kent, while making "some colored sketches" of the fishes, had two "isolated in separate glass receptacles some few yards apart, when unexpectedly a sharp little snapping noise was heard at short and regular intervals to proceed from one of the vases placed on a side table, and to which a response in a like manner was almost immediately made from the vase close at hand. On seeking for the cause, the sound was found to proceed from the mouths of the little *Hippocampi*, which were thus conversing with, or signaling to, one another. The noise observed was produced by the muscular closing and sudden expansion of the lower jaw, and much resembled in strength and tone the snapping sound produced for a similar purpose, but in this instance with its claw, by the little scarlet prawn (*Alpheus ruber*)," relatives of which occur along the southern coast of the United States.

The mechanism which produced the sounds emitted by the sea horse was explained at length by Dufossé in 1874 to whose memoir reference may be made by those who wish to learn details. Suffice it here

to note that Dufossé found that the fishes had the power of making long series of movements so slight and so rapid that they evade the sight, but are appreciable to touch, and consequently are simple quiverings or vibrations (*frémissements*), and that these quivering movements are accompanied by sounds which, however, are rarely distinctly audible (*commensurables*). The sounds are produced by females as well as males; notably in the spawning season, when they are both more frequent and more intense.

IV.

The natural food of the sea-horses consists mainly of small crustaceans, such as copepods, sand-fleas (*Gammarids*), and the opossum shrimps (*Mysids*) as well as the young of higher forms. Such being not readily obtainable by aquarium keepers, Kent improvised for his aquaria "a successful substitute in the form of the larvæ of the common gnat" or mosquito (*Culex pipiens*) and "other water insects."^a

The mode of feeding is curious. A supply of amphipodous crustaceans may be supplied to them and a fish will slowly move toward one, peering at it, approaching the mouth to it, and suddenly the animalcule may disappear without any perceptible movement of the jaws as though the fish had sucked it in. But the amphipod (or other animal) must be at rest or on the ground or a plant; for the fish is too slow to get one moving; nevertheless it must be alive. The fish may throw itself on its side or in any other attitude most fit to get hold of the coveted "bug."

V.

As the season for reproduction approaches the sexes become prepared for it. The mature female's cloaca or "genital papilla" is somewhat extended and becomes a kind of intromittent organ for the transfer of her eggs to the male. The receptive male's pouch becomes thickened and vascular and thus prepared for the reception of the eggs and the nutriment of the embryos. The males, as usual in fishes, are somewhat smaller than the females.

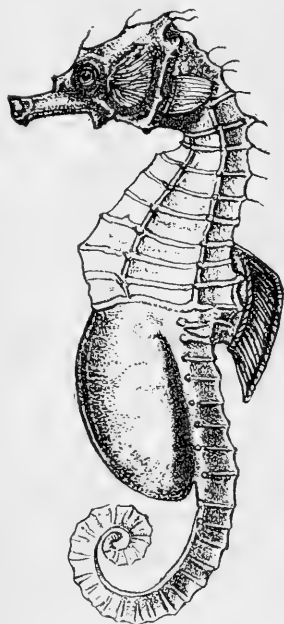


FIG. 5.—SEA-HORSE (*HIPPOCAMPUS HUDSONIUS*). MALE WITH DILATED POUCH. (AFTER KAUP.)

^a The many sea-horses in the aquaria at St. Louis (1904) were fed almost entirely on the larvæ of trout and salmon; the yolk-sac of the latter was broken before the larva could be swallowed.

Curiosity is naturally excited as to the manner in which the eggs are transferred into the narrow-mouthed ovigerous sack of the male. Many have watched, but, so far as known, the only one who has caught the female and male in the act of transfer was Dr. Filipo Fanzago. In May, 1874, the doctor observed the approach of the two in an aquarium at Naples. The approach was not once for all, but oft repeated and very short each time. The male remained passive and the egg-burdened female advanced toward him and pressed the aperture for the extrusion of the eggs against the mouth of the male's pouch. At the most a few eggs—perhaps not more than a single one—were passed from the female to the male and then she retreated. After a not very long interval—it varied—she again approached and another transfer was made. Five times Fanzago observed this strange kind of copulation in a short space of time (*in breve spazio di tempo*), but exactly how long is not stated. He hoped to be able to make further observations, but has left no other records. The eggs are doubtless fertilized during the act of transfer.



FIG. 6.—SEA-HORSE (*HIPPOCAMPUS HUDSONIUS*). VERY YOUNG WITH YELK-SAC. (AFTER LOCKWOOD.)

The ovigerous pouch is especially adapted not only for the reception of the eggs but for the sustenance of the newly hatched offspring. Dufossé (1874) found that there was a lining mucous membrane which had the faculty of secreting an aëriform fluid. Further, this function is liable to pathologic deviation, in which case the bladder may become stopped up and the fish be unable to control itself and carried to the surface of the water, where it remains helpless till death follows.

Lockwood (1868), before the investigations of Dufossé, found out for himself that the pouch may actually contribute in some way to the sustenance of the brood. "At the time of receiving the spawn the wall of the pouch is not less than 3 lines thick and well stored internally with fat. At the time of expulsion of the developed fry the same sack is not half a line thick and hangs flaccid on the animal, a mere thin membrane."

If the male would relieve itself of its burden it uses its tail. Lockwood has described the operation as he saw it. "Bending this ap-



FIG. 7.—SEA-HORSE (*HIPPOCAMPUS HUDSONIUS*). MALE DISCHARGING YOUNG FROM POUCH. (AFTER LOCKWOOD.)

pendage upward like an inverted crook, thus imparting to it muscular rigidity, the animal pressed it against the bottom of the embryonal pouch, which occupied the lower part of the abdomen, thus pushing its contents upward, and forcing them out of the opening on the top of the sack, the creature all this time sustaining its normal, erect position in the water." Another may take advantage of the presence of some object on which it can get a purchase—a winkle shell, for instance. A "winkle afforded real help in the labor of extruding the young" to another male observed by Lockwood. This operation "is in no sense a parturient process, but on the contrary is entirely mechanical, and in the present case was effected in the following manner: With its abdomen turned toward the shell, its tail attached to the under part of it, the body erected to its full height, the animal, by a contractile exertion of the proper muscles, would draw itself downward and against the shell, thus rubbing the pouch upward, and in this simple, yet effective way, expelled the fry at the opening on top of the sack." This is not a continuous operation, but each effort was "followed by a few minutes of rest," and the extrusion of the young "lasted for nearly six hours, from three to six individuals being set free at a time." The young then are fully developed.

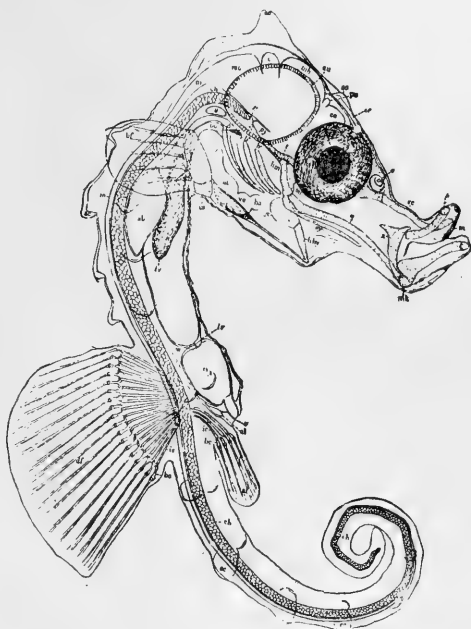


FIG. 8.—SEA-HORSE (*HIPPOCAMPUS HUDSONIUS*). YOUNG, VIEWED FROM SIDE AS A TRANSPARENT OBJECT. (REDUCED FROM RYDER.) *ab*, AIR BLADDER; *af*, ANAL FIN; *al*, URINARY VESICLE OR BLADDER; *at*, VENOUS SINUS; *au*, AUDITORY CAPSULE; *b'*, *b''*, *b'''*, FIRST, SECOND, THIRD, AND FOURTH BRANCHIAL ARCHES OF THE RIGHT SIDE; *ba*, BULBOUS AORTA; *bc*, BASIRADIAL CARTILAGES; *bf*, BREAST OR PECTORAL FIN; *c*, CEREBELLUM; *ce*, CEREBRUM; *ch*, CHORDA DORSALIS OR NOTOCHORD; *cs*, CORACOSCAPULAR ARCH; *cy*, CERATOHYAL CARTILAGE; *df*, DORSAL FIN; *e*, INTERNASAL CARTILAGE; *hh*, HYPOHYAL CARTILAGE; *hm*, HYOMANDIBULAR CARTILAGE; *ic*, INTERRADIAL CARTILAGES OR BASALIA OF FIN RAYS; *iv*, INTESTINAL VALVE; *lv*, LIVER; *m*, MEDULLA SPINALIS OR SPINAL CORD; *mb*, MID-BRAIN; *mk*, MECKEL'S CARTILAGE; *mo*, MEDULLA OBLONGATA; *mt*, METAPTERYGOID CARTILAGE; *na*, NASAL PIT; *oc*, OESOPHAGUS; *p*, PARACHORDAL CARTILAGE; *pn*, PINEAL GLAND; *py*, PITUITARY BODY; *q*, ROD-LIKE QUADRATE CARTILAGE; *rc*, ROSTRAL CARTILAGE OR PROLONGATION OF THE TRABECULAR CORNU; *ri*, RECTAL PORTION OF INTESTINE; *s*, SPIRACULAR OUTLET OF THE GILL-CHAMBER; *sc*, DERMAL SCUTES OR PLATES; *sy*, ELONGATED SYMPLECTIC; *t*, TRABECULAE CRANII SEEN FROM THE SIDE; *tc*, TEGMEN CRANII; *v*, VENT OR ANUS; *ve*, VENTRICLE OF HEART; *w*, WOLFFIAN OR SEGMENTAL DUCT; *x*, SUPRA-ANGULAR CARTILAGINOUS ELEMENT, THE RUDDIMENT OF THE SUPRAMAXILLARY.

After the exclusion of the young, connection between them and the parent ceases, so far at least as recourse to the pouch is concerned. Unlike the open-pouched pipe-fishes the sea-horses apparently can not readmit the young to the shelter of its small-mouthed sack-like pouch. It was Lockwood's "belief that with the sea-horse the termination of development is the end of their solicitude for the young."

The newly born young, 5 to 6 lines in length, are quite unlike the parent fish in some respects, while in others they resemble him. The scales are undeveloped, and instead of the pipe-like mouth the snout is short and broad; nevertheless the general form is similar to that of the adult, and the tail, though shorter and rounded, is incurved inward. The tail is immediately utilized, we are told by Lockwood.

VI.

The species of *Hippocampus* are numerous (between 30 and 40), but the many common characters are so much more prominent and striking than the specific ones that the latter are apt to be lost sight of and overshadowed by the former. The distinctions between the species are chiefly based on the length and number of rays of the dorsal fin, the number of rings encircling the body, the comparative lengths of the body and tail behind the anus, the depth of the body or distance across from the dorsal ridge to the ventral, and the relative length of the head and snout in front of the eyes. These are supplemented by the comparative development of the tubercles or spines, of the coronet at the crown of the head or nape, of the filaments with which the body may be covered, and the color. In illustration of such, figures are given of four species.

The common eastern American sea-horse (*Hippocampus hudsonius*) has a long dorsal with about 19 rays, about 45 (10+32-35) rings, the tail longer than head and trunk combined, the snout short but appreciably longer than rest of head (1.3—1.4:1), and the depth of the body approximately equals the length of the head. The coronet is little developed, the tubercles and spines weak, and the filaments rather few, short, and mostly simple. The color is dusky and spotless (but blotched) and the dorsal has a submarginal dark band.

The sea-wrack sea-horse (*Hippocampus zosterae*) of Florida contrasts with the common species of the north in most of its characters. It has a short dorsal (covering only 3 rings) with about 12 rays, about 41 (11+30) rings, the tail rather shorter than the rest of the body, the snout extremely short and not more than half the rest of the head, and the depth of the body great and almost equal to length from snout to margin of pectoral fins. The coronet is high, the spines are well developed, and the filaments moderate and often branched. The color is olive green, more or less mottled, and the dorsal has no distinct

submarginal band. It is, according to Jordan and Evermann, "the smallest known species of sea-horse, abundant in shallow water in the lagoons, always found clinging by its tail to the sea-wrack (*Zostera marina*)."

With these two species, two from Japan first described not long ago (1901) by Jordan and Snyder may be compared. The descriptions



FIG. 9.—SEA-HORSE (*Hippocampus hudsonius*). FEMALE. (AFTER JORDAN AND EVERMANN.)



FIG. 10.—SEA-HORSE (*Hippocampus zostere*). FEMALE. (AFTER JORDAN AND EVERMANN.)

here given will furnish hints enough to discriminate between them and others and indicate the range of variation.

VII.

Certain Hippocampines of southern seas, especially the *Phyllopteryx foliatus* and *Phycodurus eques*, develop exaggerated characteristics, which are more or less manifest in the ordinary sea-horses. The

cutaneous appendages, which are merely tags of skin in most species, become greatly developed, especially about the tail, and simulate in a remarkable degree the appearance of the seaweeds in which they are wont to lurk.

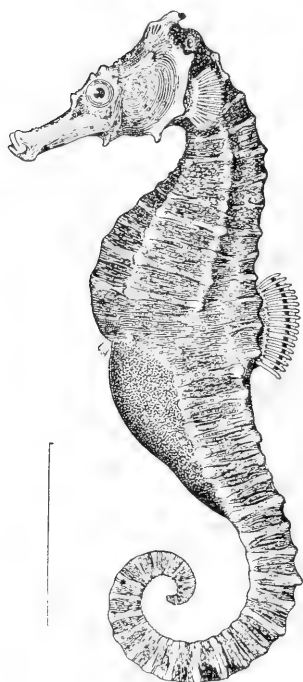


FIG. 11.—SEA-HORSE (*HIPPOCAMPUS*
ATERRIMUS). MALE.



FIG. 12.—SEA-HORSE (*HIPPOCAMPUS* *SIN-*
DONIS). MALE.

The Solegnathines have the upper ridge of the caudal region deflected and continuous into the lateral ridge, while the lower caudal ridge is continuous with the ventro-lateral ridge of the trunk; the nuchal plate is not elevated and not connate with the head. Nothing is known respecting their habits.

NOTES ON AN ADULT GOBLIN SHARK (MITSUKURINA OWSTONI) OF JAPAN.

By BARTON A. BEAN,

Assistant Curator, Division of Fishes.

In 1897 Prof. Kakiechi Mitsukuri, of the University of Tokyo, Japan, brought to the United States one of the most remarkable of living sharks and placed it in the hands of Dr. David S. Jordan, who made it the type of a distinct family of lamnoid sharks (Mitsukurinidae). The specimen was a young male, being but 42 inches long, and the 11-foot adult female which is the subject of this sketch shows quite a difference in the proportion of certain parts. The rostral appendage and caudal fin of the adult are relatively shorter than those of the young. In the latter (the type) the distance from tip of rostral appendage to eye slightly exceeds that from eye to last gill-opening, while in the adult it is contained one and one-third times in this distance; the tail of the type is contained but two and three-fourths times in the total length; in the adult, three and one-third times in this same length. The depth of body in the young animal is much greater proportionately than in the adult. As will be seen by the illustration, the body is remarkably short, only as long as the head in the young, and the head of the adult is two-thirds as long as the body.

Mr. Owston in forwarding this shark to the National Museum wrote that it was the longest so far obtained, and that they are taken mostly at Kosu, near Odawara, latitude $35^{\circ} 16'$ north, longitude $139^{\circ} 17'$ east, where there is a bank of 52 fathoms depth and depths of from 300 to 400 fathoms close by. Mostly females are taken, and in the spring-time only. It is thought that they resort to the bank to breed.

The shark appears to be fairly well known only at the exact locality given; the fishermen style it Tengu-zame, meaning goblin or elfin shark. They are caught in Naname (7-mesh) nets. Oil is extracted from the liver, and the flesh is used only for fertilizing purposes. A small one has been taken at Okinose, 10 miles south of Misaki, and others, too, have been taken on shark lines along the coast of Izu.

The following measurements were made by the writer and his son George before the shark was skinned:

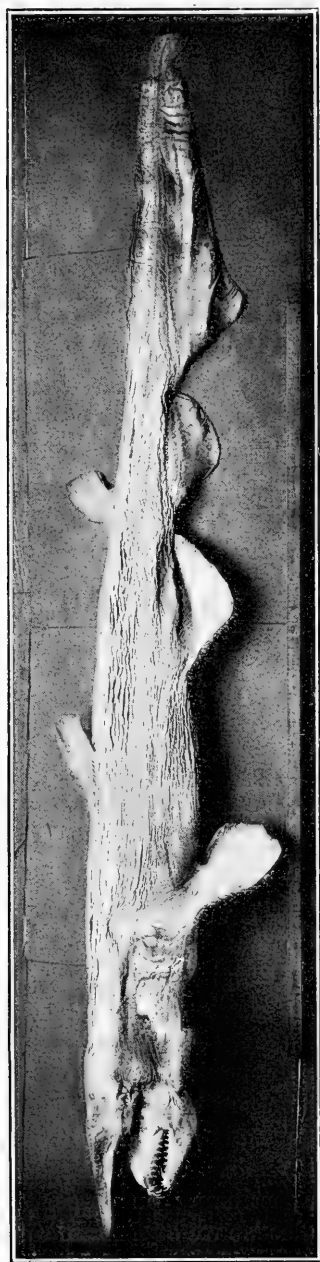


FIG. 1.—GOBLIN SHARK, *MITSKURINA OWSTONI*.

Total length, 11 feet; depth at origin of pectoral, 12 inches; depth at first dorsal, 11 inches; tip of snout to eye, $17\frac{1}{2}$ inches; tip of snout to anterior edge of first gill-opening, $27\frac{1}{2}$ inches; tip of snout to base of first dorsal, $46\frac{1}{2}$ inches; length of upper margin of tail, 39 inches; lower margin to notch, 28 inches; length of rostral appendage underneath, 12 inches; width of rostral appendage, 6 inches; width at spiracles, $7\frac{1}{2}$ inches; width between the eyes, $8\frac{1}{2}$ inches; diameter of eye, $1\frac{1}{2}$ inches; spiracle, $1\frac{1}{2}$ inches wide, $3\frac{1}{2}$ inches from front of eye and on line with it. Upper jaw grooved and prolonged beyond the lower jaw, which is deeper grooved at the synthesis than the upper. There are four rows of visible teeth, the inner row partly embedded in the flesh. Teeth long and slender, sharp-pointed, curved and recurved, and having a double base; more numerous and longer at the extremity of the jaws than posteriorly. Longest teeth in upper jaw, seven-eighths of an inch; longest in lower jaw, 1 inch. Five gill-openings.

The fin measurements in inches are as follows: Base of first dorsal, $7\frac{1}{2}$; height of first dorsal, 10; width of end of first dorsal, $3\frac{1}{4}$. The second dorsal is immediately over the space between ventrals and anal, its base, 5; height, 8; width of end, 4. Pectoral, length of outer margin, 13; inner margin, 9; and width of tip, 7. Ventral, length of base, 12; length of anterior margin, 9; width of tip, $9\frac{1}{2}$. Anal, base, 12.

The basal bones of the fins count as follows: Pectoral, 16; ventral, 23; anal, 23; second dorsal, 12.

The specimen is now preserved in the U. S. National Museum as a dried skin and a partial skeleton preserved in alcohol. It is Cat. No. 50972, U.S.N.M., and bears the following label:

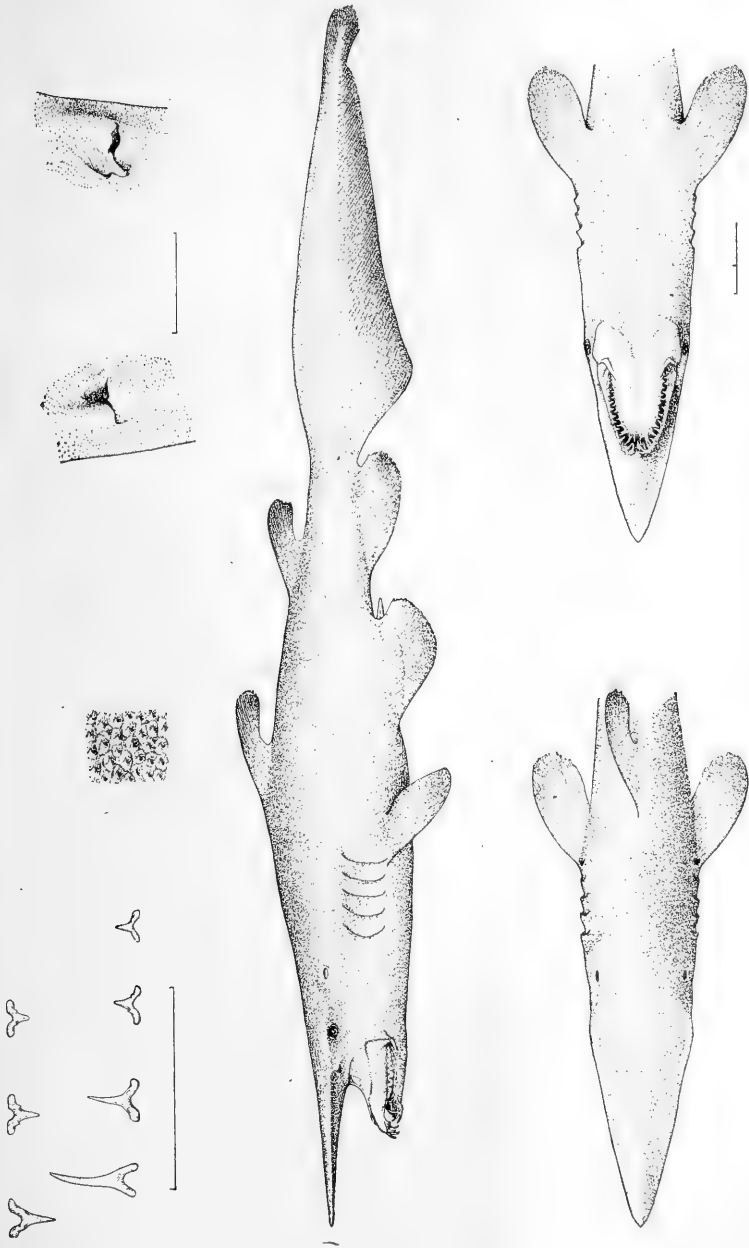


FIG. 2.—*MITSUKURINA OWSTONI* JORDAN, YOUNG MALE; TYPE.

Mitsukurina owstoni, collected for Alan Owston, of Yokohama, Japan, February 26, 1903, between Umezawa and Mayegawa, near Kosu, Sagami Bay, Japan, at a depth of from 150 to 200 fathoms. Purchased through Dr. D. S. Jordan.

The cut from a photograph by Mr. Smillie gives a very good idea of the appearance of this shark when received in Washington; it was preserved in formalin and reached us frozen quite stiff. The taxidermist, Mr. Turner, says the skin is in good condition for mounting. I understand from recent travelers to Japan that Mr. Owston has a good series of this shark on hand, ranging in length from 4 to 10 feet.

For the purpose of comparison Plate XXVI from volume 26 of the Proceedings of the U. S. National Museum is here reproduced so that the reader may readily see for himself the difference between the specimens of the young and the adult Goblin Shark.

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NOTES ON CESTODE CYSTS, *TÆNIA CHAMISSONII*, NEW
SPECIES, FROM A PORPOISE.

By EDWIN LINTON,

Of Washington and Jefferson College.

On October 7, 1901, Mr. Vinal N. Edwards, of Woods Hole, Massachusetts, collected a lot of about twenty-five cysts from the mesentery of a skunk porpoise (*Lagenorhynchus acutus*) captured at Menemsha Bight, Vineyard Sound.

This material, preserved in formalin, was submitted to me in August, 1903, at which time I made a preliminary examination of it. Later some of it was stained and sectioned.

I already had in my collection a few cysts from the same host which were collected on an expedition from Woods Hole to the tile-fish grounds, July 29, 1899.

In the older lot there were two kinds of cysts, one kind similar to those of the later lot, and, like them, obtained from the body cavity. The others were smaller, and according to the label, came from the blubber. The scolex of one of these cysts was examined and proved to be a *Phyllobothrium*.

It is with the larger cysts that this paper is especially concerned.

These cysts are, for the most part, oblong-ovate and from 20 to 30 mm. in length. Their connective tissue walls are rather thick, and are dense, tough, and leathery. Upon opening one of them a slender filament, which may be as much as five or six times as long as the cyst, is seen attached to the inner wall. One of these filaments in an averaged-sized cyst measured 127 mm. in length and less than 1 mm. in diameter.

At first sight these filaments might be mistaken for nematoid worms, but a closer examination will show them to be the inverted portions of a bladder worm (cysticercus).

By careful manipulation the connective tissue layers of the cyst may be removed and the contained bladder liberated. The outer wall of the bladder is closely adherent to the inner wall of the cyst, and the bladder itself is rather fragile in the preserved specimens.

The general plan will be best understood from the figures, the explanation of which should be read.

It will be seen readily from the figures that the filiform structure is the inverted portion of the cysticercus. The relation of these parts is shown in fig. 11.

The lumen of the filiform part is lined with cuticle which, of course, becomes the external layer when the worm is everted. The scolex is provided with four suckers which may be seen in fig. 8. Furthermore the scolex appears to be truncate in front. This at least is my interpretation of the upper part of fig. 9, near the index line *m*. Near the scolex the cuticle is much crumpled (figs. 8 and 9). In longitudinal sections the lateral vessels are seen to be spiral; slightly shown in fig. 9.

The folds on the inner wall of the bladder at the origin of the filamentar portion (*i*, in figs. 1, 2, and 5) were seen only in the lot collected by Mr. Edwards. They may be due to the action of the killing fluid.

Encysted cestode worms were recorded by Rudolphi under the name *Cysticercus delphini*.^a Cobbold summarizes the literature of the subject thus:

The presence of larval cestodes has been indicated in several whales. Thus, F. Cuvier and Van Beneden state that Surgeon-Major Carnot, in 1822, found an enormous quantity of small hydatids in the nasal sinuses of a porpoise (*Phocaena compressicaudata*). These are supposed to be cysticerci. In like manner, Mr. F. D. Bennett, in 1837, obtained numerous capsuled cysticerci from the skin and blubber of *Catodon* (*Physeter*) *macrocephala*. * * *

The naturalist Bosc noticed a larval cestode in the fatty tissue surrounding the reproductive organs of *Delphinus delphis*. He called it an hydatid (*Hydatis*), and Rudolphi placed it with the *Cysticerci* (*C. delphini*). According to Van Beneden [P.-J.] the parasite in question is probably a sexually immature example of *Phyllobothrium delphini* described by his son. Edward Van Beneden found this scolex in great abundance in a dolphin (*D. delphis*), which he dissected at Concarneau in 1868. (*Parasites of Man and Animals*, pp. 421-422.)

The cysts described by Ed. Van Beneden^b undoubtedly belong to the genus *Phyllobothrium*. In like manner the description given by Rudolphi,^c under *Cysticercus delphini*, points to the genus *Phyllobothrium*.

On the other hand, Rudolphi's account of *Cysticercus delphini*^d indicates a very different form from that recorded under the same name in his History of the Entozoa, and appears, indeed, to be identical with the cysts under consideration in this paper.

In the Synopsis^e Rudolphi gives a brief account of some very interesting specimens which had been brought to him by his very dear friend Chamisso, having been collected by the poet-naturalist in his

^a Entoz. Hist., II, Pt. 2, p. 236; Synopsis, pp. 182, 544, and 551.

^b Bull. Acad. Belgique, XXIX, 1870, p. 360.

^c Entoz. Hist., II, Pt. 2, p. 236.

^d Synopsis, p. 551.

journey around the world, and brought back to Rudolphi as a mark of his regard for the renowned helminthologist.

Unfortunately the alcohol in which the cysts had been preserved was too weak and consequently the material was not in good condition for study. So that nothing remained except the hard external vesicle, which, he states, is harder and more coriaceous than ordinarily (*solito durior et coriacea*).

The cysticercus itself, he says, had lost its opening, and one of them exhibited a decidedly oblong-ovate form, with the anterior part very broad, the body and head being retracted. This he was not able to preserve even by pouring stronger alcohol upon it. Moreover, in the macerating cysticercus the interior part of the vesicle was seen to contain a filamentous portion which was somewhat long and slender, and which, when examined under the microscope, might be said to be slightly crenulated on both sides or to consist of wrinkle-like segments. The description closes with the remark that no one had ever before seen a similar structure in other cysticerci, and for that reason a further examination of the species is especially commended.

I think there can be little doubt that the description paraphrased above applies to cysts specifically identical with those which are the subject-matter of this paper, and furthermore that they are the sexually immature stage of an undescribed species of *Tenia* or closely related genus.

Since it is desirable that there should be a definite name for these highly characteristic cysts, the new specific name *Tenia chamissonii* is proposed for them.

Cobbold indicates the probable final host of *Cysticercus delphini* thus:

The sexually mature state of this worm, as the Belgian savants (Beneden, father and son) remark, is to be looked for in some one or other of the larger sharks.

This will doubtless prove true, since the adult form would be a *Phyllobothrium*, and that genus is peculiar to selachians.

This will doubtless be the case with respect to the final host of *Phyllobothrium delphini*, since that genus is peculiar to selachians.

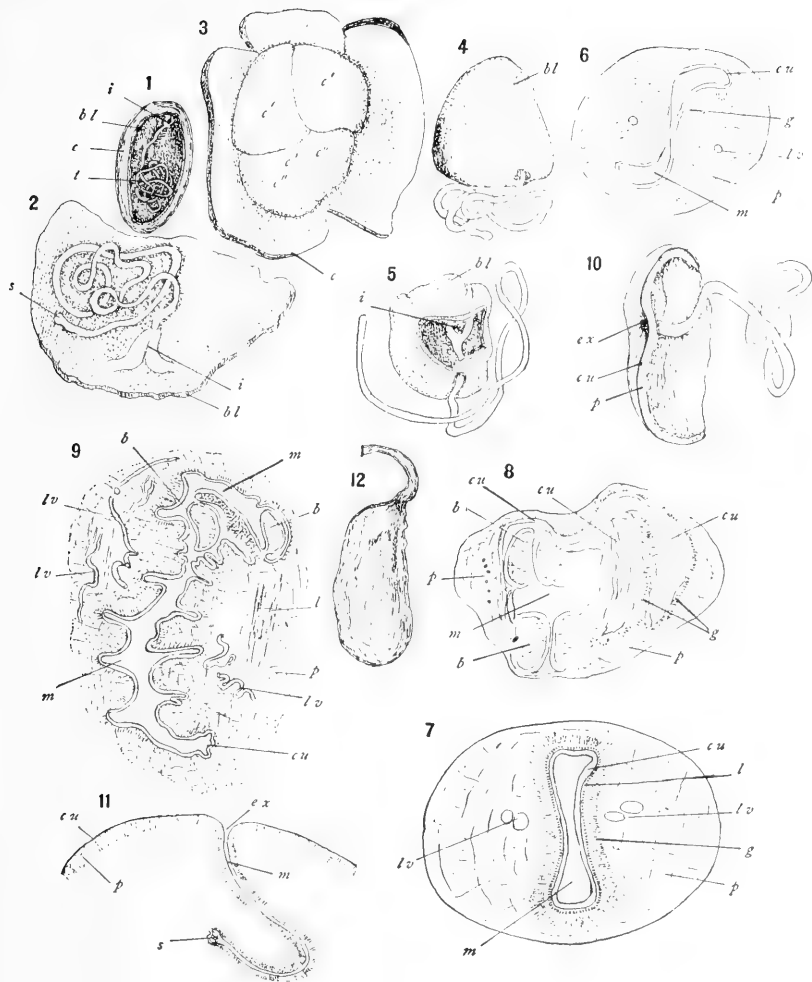
It can hardly be the fate of Chamisso's cysticercus, however, which, being a true bladder worm, and not a plerocercus, characteristic of *Phyllobothrium* and its allies, rather suggests a mammal as the final host. It is more likely therefore that the final host of Chamisso's cysticercus will be found to be some pedaceous mammal like the killer whale (*Orcinus orca*).

EXPLANATION OF PLATE XXXV.

Letters having the same meaning in the different figures:

- b.* Suckers of scolex.
- bl.* Bladder of cysticercus.
- c, c', c''.* Cyst of connective tissue inclosing bladder.
- cu.* Cuticle.
- ex.* External pore communicating with inverted portion of cysticercus.
- g.* Granulo-fibrous layer of inverted portion of cysticercus.
- i.* Folds on inner wall of bladder at point of inversion.
- l.* Fine longitudinal fibers.
- lv.* Lateral, longitudinal vessels of inverted portion of cysticercus.
- m.* Lumen of inverted portion of cysticercus.
- p.* Parenchyma.
- s.* Scolex.
- t.* Filiform inverted portion of cysticercus.

- Fig. 1. Cyst cut open on one side, showing the outer and thicker connective tissue layer *c* of the cyst proper, the inner and thinner layer *bl* or bladder, the point of inversion *i*, and the filiform, inverted portion *t*. Actual length of cyst 30 mm.
2. Bladder removed from cyst, opened and reflected, showing the filiform portion with its point of attachment and the blunt, inverted scolex. Enlarged about 2 diameters.
3. A large cyst, 48 by 40 by 22 mm. in the three principal diameters. The outer wall has been cut open and reflected, showing that what at first appeared to be one cyst has others included within its outer wall. Each of the included cysts is surrounded by connective tissue. Upon removal of the outer coat there appeared to be three cysts inclosed, *c'*. One of these, after further removal of connective tissue, was found to inclose two cysts, *c''*. In other words, the primary cyst inclosed four bladder worms, which, starting from four larvæ near together, grew and became enveloped, at first in individual cysts and later in a common cyst, *c*.
4. Cysticercus removed from cyst. The filiform portion is protruding from a perforation in the wall of the bladder.
5. Another cysticercus with a window cut in the wall to show that the filiform portion is not everted, but is perforating the wall.
6. Transverse section of filiform portion of cysticercus near the scolex. The section was 0.45 by 0.37 mm. in the two principal diameters.
7. Transverse section of filiform portion of cysticercus near middle of its length. The section was 0.66 by 0.50 mm. in the two principal diameters.
8. A nearly transverse section through the scolex.
9. A nearly longitudinal section through the scolex.
10. A cysticercus with a portion of the bladder cut away so as to show the pore on the exterior and its continuation in the filiform portion.
11. Diagram showing the relation of the bladder to the inverted filiform portion and scolex.
12. Pediceled cyst; actual length of cyst, not including pedicel, 30 mm.
- Figures 1 to 7 from lot collected October 7, 1901; figures 8 to 10 and 12 from lot collected July 29, 1899.

BLADDER WORM (*TÆNIA CHAMISSONII*) FROM PORPOISE.

FOR EXPLANATION OF PLATE SEE PAGE 822.



BIRDS COLLECTED BY DR. W. L. ABBOTT IN THE KILIMANJARO REGION, EAST AFRICA.

By HARRY C. OBERHOLSER,

Assistant Ornithologist, Department of Agriculture.

The first collection of birds received by the United States National Museum from the well-known and generous traveler and collector, Dr. W. L. Abbott, was gathered by him on famous Mount Kilimanjaro and in the neighboring region east and south, chiefly during the years 1888 and 1889.

Doctor Abbott reached Kidudwe, 90 miles inland from Zanzibar, in December, 1887, journeying thence to Taveta, in southeastern British East Africa, which latter place formed, as it were, his base of operations for the two years that followed. Collecting was assiduously carried on at various places in the environs of Taveta, and trips were made to Lake Jipé, Lake Chala, Kahé, Aruscha-wa-chini, and the Useri River, while Mount Kilimanjaro itself was several times ascended and collections made at various altitudes up to 14,000 feet. Early in January of 1890 the Teita Hills were visited, and about the middle of the same month Mombasa on the coast was finally reached. The localities at which birds were obtained, together with the months in which the respective collecting was done, are given below:

Kidudwe.—In German East Africa, 90 miles inland from Zanzibar. December, 1887.

Mount Kilimanjaro.—On the boundary between German East Africa and British East Africa, but lying mostly in the former, about 250 miles from the coast, and some 450 miles southeast of Victoria Nyanza; altitude 19,780 feet. April, May, June, July, August, and November, 1888; August, September, November, and December, 1889; January, 1890.

Foot of Mount Kilimanjaro.—At the southeast side. April, 1888.

Mandara's, Mount Kilimanjaro.—On the mountain, at 5,000 feet. August and September, 1889.

Maranu, Mount Kilimanjaro.—On the southeastern slope of the mountain, at 5,000 feet. Possibly the same as Marangu. April and September, 1888.

Plains of Kilimanjaro—Plains near Mount Kilimanjaro—Plains east of Mount Kilimanjaro.—Near the east base of the mountain. August, September, October, December, 1888; January and July, 1889.

Useri, Kilimanjaro—Useri River.—Near the east base of Mount Kilimanjaro. July, August, September, October, December, 1888; January and July, 1889.

Taveta.—In British East Africa, about 20 or 25 miles southeast of Mount Kilimanjaro. February, March, April, May, June, July, August, September, November, December, 1888; January, February, and April, 1889.

Plains of Taveta.—Near Taveta. June, July, and August, 1888.

Lumi River.—In the vicinity of Taveta. October and November, 1888.

Lake Jipé.—In German East Africa, 10 or 15 miles south of Taveta. May, 1888.

Plains of Lake Jipé.—Near Lake Jipé. May, 1888.

Lake Chala.—Between Taveta and the base of Mount Kilimanjaro, 10 or 15 miles northwest of the former. July and August, 1888.

Kahé.—South of Mount Kilimanjaro, and west of Taveta. May, September, November, 1888; August, 1889.

Plains southwest of Mount Kilimanjaro.—May, 1889.

Aruscha-wa-chini.—In German East Africa, southwest of Mount Kilimanjaro. October and November, 1888.

Teita Hills.—In British East Africa, about 75 miles east of Mount Kilimanjaro. January, 1890.

Mombasa.—On the coast of southern British East Africa, about 150 miles north of Zanzibar. January, 1890.

Mount Kilimanjaro is classic ground, ornithologically, and few localities in Africa are now better known. Situated, as it is, approximately midway between north and south, the Kilimanjaro district is part Abyssinian, part South African in its affinities, possessing at the same time, however, a considerable proportion of endemic forms. Strange to say a surprisingly small number of the mountain species are identical with those of Mount Kenia in British East Africa, some 200 miles to the northward, a fact to which attention has already been called.

Several collectors preceded Doctor Abbott in this region and many have followed him, but few have achieved more important results, and it is a matter of great regret that the published report on this material should have been so long delayed. Dr. Charles W. Richmond based the genus *Heterotrogon*^a on specimens from this collection, and described ten new forms,^b but little else concerning these birds of Doctor Abbott's has hitherto been printed, though many of them were

^a Proc. U. S. Nat. Mus., XVII, 1895, pp. 601–603.

^b Auk, XIV, 1897, pp. 154–164.

tentatively identified by Mr. Robert Ridgway, and later also by Doctor Richmond. The 684 specimens represent 256 species and subspecies belonging to 59 families. Most of the novelties have already been described, but a few will be found named for the first time in the succeeding pages, together with several new genera created for species first obtained by Doctor Abbott, as well as for some previously known. Aside from these, there are a number of rare birds such as *Francolinus uluensis*, *Caprimulgus donaldsoni*, *Micropus myoptilus*, *Melittophagus oreobates*, *Hyphantornis schillingsi*, *Nigrita diabolica*, *Pseudonigrita cabanisi*, *Pinarochroa hypospodia*, *Cisticola hunteri*, *Bradypterus barratti*, *Batis mixta*, *Parus thruppi barakæ*, and *Zosterops eurycicota*; also others in plumages that are undescribed; and still other specimens that even at this late day extend the range of their respective species. The best idea, however, of the marvelous richness of this collection of Doctor Abbott's is probably furnished by the subjoined list of 62 species and subspecies that were undescribed when obtained by him, an exposition that is possibly of more than passing interest as indicative of the great progress in African ornithology that the past eighteen years have witnessed:

Struthio massaicus Neumann.

Asbur sparsimfasciatus aceletus Oberholser.^a

Francolinus uluensis Grant.

Numida reichenowi Grant.

Numida intermedia Neumann.

Pterocles gutturalis saturator Hartert.

Turtur semitorquatus intermedius Erlanger.

Turtur capicola tropicus Reichenow.

Stigmatopelia senegalensis aquatorialis (Erlanger).

Æna capensis anonyma Oberholser.^a

Chalcopelia chalcospila acanthina Oberholser.^a

Eurystomus afer suahelicus Neumann.

Melittophagus oreobates Sharpe.

Lophoceros melanoleucos suahelicus Neumann.

Rhinopomastus cyanomelas schalowi (Neumann).

Asio maculosus amerimnus Oberholser.^a

Caprimulgus donaldsoni Sharpe.

Lybius abbotti Richmond.

Smilorhis kilimensis Shelley.

Viridibucco leucomystax (Sharpe).

Melignotheres exilis meliphilus Oberholser.^a

Dendropicus guineensis massaicus Neumann.

Hyphantornis jacksoni (Shelley).

^a New subspecies.

Hyphantornis schillingsi (Reichenow).

Estrilda cyanocephala Richmond.

Nigrita diabolica (Reichenow and Neumann).

Hypochoera anauropteryx Sharpe.

Coccyppia dufresni kilimensis (Sharpe).

Arizelopsar femoralis (Richmond).

Stilbopsar stuhlmanni Reichenow.

Arizelocichla nigriceps (Shelley).

Arizelocichla striifacies (Reichenow and Neumann).

Pycnonotus layardi micrus Oberholser.^a

Phyllastrephus cerviniventris Shelley.

Phyllastrephus placidus (Shelley).

Argya saturata Sharpe.

Cossypha caffra iolema Reichenow.

Cichladusa guttata rufipennis (Sharpe).

Cisticola hunteri Shelley.

Cisticola prinioides Neumann.

Bradypterus cinnamomeus saladorii (Neumann).

Apalis thescela Oberholser.^b

Apalis griseiceps Reichenow and Neumann.

Sylvietta whytii jacksoni (Sharpe).

Muscicapa striata neumanni (Poche).

Chloropeta natalensis similis (Richmond).

Batis mixta (Shelley).

Platysteira cryptoleuca Oberholser.^b

^b New species.

Tchitrea suchelica (Reichenow).
Cryptolopha umbrovirens dorcadichrou
 (Reichenow and Neumann).
Parus thruppi barakæ (Jackson).
Laniarius abbotti Richmond.
Nilaus afer minor (Sharpe).
Prionops vinaccigularis Richmond.
Zosterops senegalensis flavilateralis (Reichenow).

Helionympha nectarinioides (Richmond).
Nectarinia tacaze unisplendens Neumann.
Psalidoprocne holomelas massaica Neumann.
Hirundo emini Reichenow.
Macronyx aurantiigularis Reichenow.
Crithagra albifrons Sharpe.
Crithagra striolata affinis Richmond.

The writer has to thank Dr. R. Bowdler Sharpe, of the British Museum, who, at Doctor Richmond's request, identified a number of the more obscure forms in the collection—a very acceptable service, since in these cases the United States National Museum possessed little or no material for comparison.

To the authorities of the Philadelphia Academy of Natural Sciences, through Mr. Witmer Stone, for access to the library and for the loan of specimens, as well as to Mr. Glover M. Allen for the verification of several important references from books not available in Washington, the writer's thanks are also due. But he is under particular obligation to Dr. Charles W. Richmond for freely placing at his disposal many manuscript notes on the species of the collection, and for timely assistance of many and various kinds too numerous to recount.

All matter between quotation marks, unless otherwise specifically stated, is to be credited to Doctor Abbott, whose field notes on the specimen labels have been almost invariably transcribed. All measurements are in millimeters.

Family STRUTHIONIDÆ.

STRUTHIO MASSAICUS Neumann.

Struthio massaicus NEUMANN, Journ. f. Ornith., 1898, p. 243 (Ukamba, British East Africa).

This recently described ostrich is represented in Doctor Abbott's collection by the skin of a head and neck, which was obtained somewhere in East Africa, probably in the neighborhood of Mount Kilimanjaro.

Family PHALACROCORACIDÆ.

PHALACROCORAX LUCIDUS LUGUBRIS (Rüppell).

Phalacrocorax lugubris RÜPPELL, Syst. Uebers. Vög. Nord-Ost-Afr., 1845, p. 134, pl. L (Shoa, Abyssinia).

One female, from Lake Chala, near Mount Kilimanjaro, July 2, 1888. This example is apparently quite typical of *Phalacrocorax l. lugubris*, the wing measuring 315 mm., the exposed culmen 65 mm. The upper breast is black mixed with white, exhibiting therefore a

condition intermediate between *P. l. lugubris* and Doctor Reichenow's *Phalacrocorax gutturalis*,^a and indicating strongly that the latter is, as it has been recently considered by its describer,^b merely an adventitious variation of the former.

PHALACROCORAX AFRICANUS (Gmelin).

Pelecanus africanus GMELIN, Syst. Nat., I, ii, 1788, p. 577 (Africa).

One specimen, from Taveta, February 5, 1889. "Length 20 inches [508 mm.]; iris red; bill orange yellow."

Family ARDEIDÆ.

ARDEA MELANOCEPHALA Vigors and Children.

Ardea melanocephala VIGORS and CHILDREN, in Denh. and Clapp. Narr. Trav. Afr., II, App., 1826, p. 201 (Lake Tchad, Bornou).

One adult female, from the plains east of Mount Kilimanjaro, December 11, 1888.

HERODIAS ALBA (Linnæus).

Ardea alba LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 144 (Europe [type locality, Sweden]).

One adult, from "East Africa."

NYCTICORAX NYCTICORAX (Linnæus).

Ardea nycticorax LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 142 (southern Europe).

One specimen, without data.

ARDEOLA RALLOIDES (Scopoli).

Ardea ralloides SCOPOLI, Ann. Hist. Nat., I, 1769, p. 88 (no locality given).

One specimen, a female, from the Useri River, near Mount Kilimanjaro, August 27, 1888.

Family CICONIIDÆ.

CICONIA CICONIA (Linnæus).

Ardea ciconia LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 142 (Europe, Asia, Africa [type locality, Sweden]).

One specimen, from eastern Africa.

^a Journ. f. Ornith., 1892, p. 5 (Bukoba, Victoria Nyanza, German East Africa).

^b Reichenow, Vögel Africas, I, 1900, p. 90.

Family IBIDIDÆ.

IBIS ÆTHIOPICA (Latham).

Tantalus æthiopicus LATHAM, Ind. Orn., II, 1790, p. 706 ("Æthiopia").

Two specimens, from Aruscha-wa-chini, south of Mount Kilimanjaro, October 25, 1889. "Iris brown; sclerotics red; head, neck, and feet black; bare skin under wings carmine."

HAGEDASHIA HAGEDASH (Latham).

Tantalus hagedash LATHAM, Ind. Orn., II, 1790, p. 709 (Cape of Good Hope, southern Africa).

One specimen, from East Africa, with no indication of more exact locality.

Family ANATIDÆ.

ALOPOCHEN ÆGYPTIACA (Linnæus).

Anas ægyptiaca LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 197 (Egypt).

One adult male, from the plains of Mount Kilimanjaro, August 22, 1888.

PÆCILONITTA ERYTHRORHYNCHA (Gmelin).

Anas erythroryncha GMELIN, Syst. Nat., I, ii, 1788, p. 517 (Cape of Good Hope, southern Africa).

One female, from the Useri River, on the Kilimanjaro plains, August 27, 1888.

The generic name of this duck has suffered much at the hands of purist emenders; the original and therefore proper form of the word, as written above, is rarely seen.

THALASSORNIS LEUCONOTA Eyton.

Thalassornis leuconotus EYTON, Mon. Anat., 1838, p. 168 (Cape of Good Hope, southern Africa).

Two specimens—male and female—from the plains southwest of Mount Kilimanjaro, May 10, 1889.

The bird described by Doctor Richmond as *Thalassornis insularis*,^a from specimens collected by Doctor Abbott in Madagascar, seems to be undoubtedly distinct, and differs from the continental species as he has indicated.^a

^aProc. U. S. Nat. Mus., XIX, 1897, p. 678 (River Sakalés).

Family FALCONIDÆ.

GYMNOGENYS^a TYPICA (Smith).

Poloboroides [sic] *typicus* SMITH, S. Afr. Quar. Journ., II, 1830, p. 107 (eastern Cape Colony, South Africa).

One male, from Taveta, taken February 5, 1889. It is not quite adult, some of the brown feathers of the juvenal plumage still persisting above and below; and the lower tail-coverts are mostly slate color barred with white. "Iris white; feet and the bare skin surrounding the eyes yellow."

MICRONISUS GABAR (Daudin).

Falco gabar DAUDIN, Traité d'Orn., II, 1800, p. 87 ("près des rivières Swart-Kop et Sondag; Camdeboo; entre les montagnes de Neige et le Bock-Veld [type locality, Swart-Kop River, Cape Colony]).

One immature female, from Taveta, January 31, 1889. "Iris light yellow; feet straw yellow."

ASTUR SPARSIMFASCIATUS ACELETUS, new subspecies.

Chars. subsp.—Resembling *Astur sparsimfasciatus sparsimfasciatus*,^b but bill smaller; the throat, middle of abdomen, and lower tail-coverts barred with brown.

Description.—Type, adult female, Cat. No. 117876, U.S.N.M.; Taveta, British East Africa, July 7, 1888; Dr. W. L. Abbott. Upper surface brownish slate color, almost clear slate on the nape; tail sepia brown with a narrow white tip and three or four broad rather light-brown bands which, on a few of the feathers, chiefly basally, become whitish along the inner edge of the interior webs, but the middle pair entirely without white; under surface of tail paler, the light spaces brownish gray and better defined than above; wing-quills *sc*₁ barred basally on their inner webs with white, which is, however, all concealed in the closed wing; wing-coverts brownish slate, like the upper parts; sides of head and neck slate color with a brownish tinge; entire lower surface buffy white, the chin, upper throat, middle of abdomen, and under tail-coverts with narrow, widely spaced bars of hair brown, the rest of the inferior surface with broad, dark, warm hair-brown bars that are often narrowly margined with tawny; thighs more closely barred with the same color, but the more conspicuous tawny margins produce a rufescent general appearance; lining of wing buffy white, with mottlings and irregular bars of sepia and bistre. Length of wing, 251; tail, 218; exposed culmen with cere, 25;

^a See Richmond, Auk, 1902, p. 92.

^b *Astur sparsimfasciatus* Reichenow, Ornith. Monatsber., 1895, p. 97 (Zanzibar, eastern Africa).

culmen without cere, 19; tarsus, 65; middle toe, 38; middle claw, 15; hind claw, 23 mm.

This evidently new form of an interesting yet rather difficult group differs from *Astur tachiro* and its various subspecies most noticeably in its much larger size, strikingly stouter feet and tarsi, lack of white markings on the middle tail-feathers, and rather wider white interspaces of the ventral surface. Doctor Reichenow has recently reduced *Astur sparsimfasciatus* to a subspecies of *Astur tachiro*,^a but he probably errs in so doing, since the former, by his own showing,^b occurs almost exclusively within the known range of the latter; the differences are such as would appear to be specific rather than subspecific; and furthermore, there is no evidence of intergradation. The discovery of the present new form, only a short distance across the mountain from Moschi, where Mr. Neumann found what he considered typical *A. tachiro*,^c is added proof of the distinctness of the two species.

Doctor Abbott obtained only the single specimen above described, and the bird appears to be rare. He notes the native name (Ki Taveta) as "Kinui."

BUTEO AUGUR (Rüppell).

Falco (Buteo) augur RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 38, pl. xvi (Abyssinia).

Four specimens from Mount Kilimanjaro, at 4,000 and 5,000 feet. The three adults all have the lower tail-coverts more or less tipped with tawny. "Iris brown; feet and cere yellow; bill horn blue; Native name 'giáhm'. Length (of male) 20½ inches [514 mm.]." An immature female just passing into the adult plumage has still the brown, light-barred tail and the large spots on the breast, but many black feathers are appearing in the plumage of the upper parts, while the chin and throat are streaked with black as in the adult; the posterior lower surface is strongly tinged with tawny, the thighs and crissum somewhat mottled with the same; the wings are much less blackish than those of the adult, and most of their conspicuous grayish white markings are, particularly on the outer webs, either absent or obscured.

BUTEO DESERTORUM (Daudin).

Falco desertorum DAUDIN, Traité d'Orn., II, 1800, p. 162 (based on Levaillant; no locality given, but probably southern Africa).

One immature female from Mount Kilimanjaro, 5,000 feet, September 1, 1889. This individual is not pure white below, but is tinged with buff on breast, sides, and abdomen, and with ochraceous on flags and crissum. "Iris straw color; cere light green."

^a Vögel Africas, I, 1901, p. 554.

^b Idem, pp. 552-554.

^c Journ. f. Ornith., 1899, p. 42.

AQUILA RAPAX (Temminck).

Falco rapax TEMMINCK, Pl. Col., I, 1828, pl. cccclv (southern Africa).

Two rather worn specimens: an adult male from the plains east of Mount Kilimanjaro, September 21, 1888; and an immature female from the plains of Taveta, July 5, 1888. Both have the cervix lighter than the back—possibly a peculiarity of their abraded condition.

LOPHOAETUS OCCIPITALIS (Daudin).

Falco occipitalis DAUDIN, Traité d'Orn., II, 1800, p. 40 ("pays d'Auteniquoi et Caffrerie").

One adult female, from Mount Kilimanjaro, 5,000 feet, October 1, 1889.

KAUPIFALCO MONOGRAMMICUS MONOGRAMMICUS (Temminck).

Falco monogrammicus TEMMINCK, Pl. Col., I, 1824, pl. cccxiv (Senegal, western Africa).

One adult female, from Taveta, January 31, 1889.

The generic name *Kaupifalco* Bonaparte,^a founded upon this species, is long anterior to the current *Asturimula* Finsch and Hartlaub,^b and should be employed for the group.

CIRCAETUS CINEREUS Vieillot.

Circæetus cinereus VIEILLOT, Nouv. Dict. d'Hist. Nat., XXIII, 1818, p. 445 (Senegal).

One specimen, an apparently adult female, from Kahé, September 5, 1888. "Iris orange yellow; feet dirty greenish white."

PONTOAETUS VOCIFER (Daudin).

Falco vocifer DAUDIN, Traité d'Orn., II, 1800, p. 65 (type locality, Delagoa Bay, Portuguese East Africa).

Haliæetus vocifer AUTHORS.

One fine old female of this magnificent eagle is in the collection. It was obtained at Taveta, April 29, 1888. "Iris and feet soiled white; cere yellow."

MILVUS ÆGYPTIUS (Gmelin).

Falco ægyptius GMELIN, Syst. Nat., I, i, 1788, p. 261 (Egypt).

Five specimens: from Taveta; Mount Kilimanjaro at 5,000 feet; and the plains east of this mountain. An adult female, taken March 25, 1888, had the "bill and feet yellow." An adult male, November 14, 1889, measured in the flesh 22½ inches (581 mm.) in length, and 53½

^a Rev. et Mag. de Zool., 1854, p. 533.

^b Finsch and Hartlaub, Vög. Ost-Afr., 1870, p. 59.

inches (1,359 mm.) in extent; an immature male, December 23, 1889, was $21\frac{1}{2}$ inches (540 mm.) long: "Iris dark brown; bill black; cere and feet yellow." There is a conspicuous range of individual color variation in this species, even among adult birds.

POLIHIERAX SEMITORQUATUS (Smith).

Falco similitorquata [err. typ.] SMITH, Rep. Exped. Explor. Cent. Afr., 1836, p. 44 (near old Latakoo, Bechuana Land, South Africa).

Two specimens of this diminutive falcon are in the collection—an immature female from the plains east of Mount Kilimanjaro, October 3, 1888, and an adult male from the Teita Hills, January 11, 1890. "Feet and cere (of adult male) red; bare skin around eyes red; iris brown; bill very light slate blue, the tip black." In our immature female the white collar on the hind neck is deeply tinged with chestnut and ochraceous; the broad, light terminals of the secondaries are strongly rufescent; the primaries and rectrices are tipped with chestnut or tawny; and the feathers of the entire lower parts, except the chin and upper throat, have fine blackish shaft streaks.

Family TURNICIDÆ.

TURNIX SYLVATICA LEPURANA (Smith).

Ortygis lepurana SMITH, Rep. Exped. Explor. Cent. Afr., 1836, p. 55 (Kurri-chaine, Bechuana Land, South Africa.)

Two specimens: Aruscha-wa-chini, October 26, 1889; and Kahé, south side of Mount Kilimanjaro, May 4, 1888.

Family PHASIANIDÆ.

FRANCOLINUS SEPHÆNA GRANTII (Hartlaub).

Francolinus grantii HARTLAUB, Proc. Zool. Soc. Lond., 1865, p. 665, pl. xxxix fig. 1 (Unyamwezi, German East Africa).

Five specimens, from Taveta. The female is smaller than the male, is without spurs, and somewhat paler, more grayish on the upper surface, though there seems to be no difference on the lower parts. A bird in juvenal plumage, taken March 21, 1888, is in color above very similar to the adult female, differing chiefly in being rather paler, with less black on the nape; there is also less chestnut spotting on the jugulum; the ground color of the posterior lower parts, excepting the crissum, is deeper buff, and only a very little streaked and barred with pale grayish, this confined mostly to the breast and sides.

FRANCOLINUS ULUENSIS Grant.

Francolinus uluensis GRANT, Ibis, 1892, p. 44 (Machako's, Ulu country, British East Africa).

Three specimens: one from Taveta; one from Lake Chala, near Mount Kilimanjaro; the other without data. All appear to be typical, bearing out the specific characters assigned by Mr. Grant. This species has hitherto been reported only from Ukamba and the Ulu country, south of Mount Kenia, so that Doctor Abbott's specimens extend its range some distance to the southward. Two of these examples are further interesting on account of being females. They are smaller than the male, and lack spurs, but are quite similar in plumage, except for being possibly a little more grayish on the upper parts. They measure as follows:

Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
		mm.	mm.	mm.	mm.	mm.
Lake Chala.....	Aug. 20, 1888	166	83	24	41	27
Taveta	Apr. 18, 1889	159	76	28	39	28

FRANCOLINUS HILDEBRANDTI HILDEBRANDTI Cabanis.

Francolinus (Scleroptera) hildebrandti CABANIS, Journ. f. Ornith., 1878, pp. 206, 243, pl. iv, fig. 2 (Ndi, Teita, British East Africa).

Six specimens, from Mount Kilimanjaro, at 5,000 feet. One of the two adult females differs from the other in having considerably paler lower parts, a conspicuous mottling of blackish on the feathers of the upper breast, and very broad dark-brown instead of rufous bars on the lower tail-coverts. An immature female corresponds very closely to the description of a similar specimen, the type of *Francolinus fischeri*, given by Reichenow,^a and in color differs from the adult of the same sex in being lighter, much more coarsely mottled above, the tertials particularly with large spear-shaped spots of deep brown; very much paler below—ochraceous buff in place of deep tawny, many of the feathers broadly margined with whitish, the chin and throat whitish, the jugulum, breast, and sides of neck heavily streaked and spotted with blackish brown, the sides of the body broadly streaked with the same color; lower tail-coverts with but small obsolete sub-terminal markings of dusky. The tarsal spur is not absent in the adult female, but is shorter, stouter, and not so sharp as in the male. Doctor Abbott reports this species "very common, to judge from the numbers of snared ones brought for sale by the natives."

^a Vögel Africas, I, 1901, pp. 478-479.

FRANCOLINUS SCHUETTI SCHUETTI Cabanis.

Francolinus (Scleroptera) schuetti CABANIS, Journ. f. Ornith., 1880, p. 351 (Northern Lunda, Kongo Free State).

Five specimens from Mount Kilimanjaro, 5,000 and 7,000 feet. Of an adult male, obtained April 6, 1888, Doctor Abbott says: "Brought alive by natives; bill and feet red, iris dark brown." The female is smaller than the male, but not appreciably different in color.

As the juvenal plumage of this species seems to be unknown, the following description, taken from a specimen collected August 9, 1888, may be of interest: Pileum bistre brown, almost uniform; rest of upper parts, including the tail, rich vandyke brown, the feathers of the nape, back, and scapulars with large black subterminal markings, and furthermore varied with bars and small shaft streaks of buff, tawny, or ochraceous; rump and upper tail-coverts obscurely, irregularly, and narrowly barred with blackish and tawny; the tail barred narrowly with dusky; wings fuscous, the coverts and outer webs of the quills reddish brown, paler than the upper surface of the body, finely vermiculated and obsoletely barred with blackish, the coverts and the primaries in places with additional bars of ochraceous, the tertials marked with black like the feathers of the back; extreme forehead, lores, orbital region, and broad supercilium ochraceous buff; cheeks and auriculars dull brown, slightly mixed with grayish; chin plain buffy white; breast and jugulum, including the sides of the neck, mottled with blackish brown, ochraceous, buff, and whitish, chiefly in more or less irregular bars, the feathers with pale shaft lines; remainder of lower parts prout's brown, paler medially, rather more rufescent posteriorly, everywhere with various blackish, ochraceous, and whitish markings, all these most obscured on the crissum; sides and flanks with buffy shaft lines.

PTERNISTES LEUCOSCEPUS INFUSCATUS (Cabanis).

Pternistes infuscatus CABANIS, Journ. f. Ornith., 1868, p. 413 (Lake Jipé, German East Africa).

Three typical specimens without data, but presumably from the neighborhood of Mount Kilimanjaro.

Family **PERDICIDÆ**.**COTURNIX DELEGORGUEI** Delegorgue.

Coturnix delegorguei DELEGORGUE, Voy. l'Afr. Austr., II, 1847, p. 615 (Limpopo River, southeastern Africa).

Six specimens, from Taveta, and Mount Kilimanjaro at 5,000 feet altitude. "Iris of adult male light brown; feet light straw color." An immature male, taken December 25, 1889, on Mount Kilimanjaro,

differs from the adult of the same sex in being appreciably paler, both above and below; the anchor-shaped mark on the white throat is more brownish; the black median area of the ventral surface is more restricted, posteriorly brownish, and with edgings of pale grayish; the streaks on sides and flanks are noticeably smaller; "iris light brown; feet pale flesh color." The single adult female, which contained eggs ready for extrusion, is apparently of exceptional size, being larger than any of the males; wing, 103; tail, 27; exposed culmen, 12; tarsus, 25; middle toe, 22 mm.

Family NUMIDIDÆ.

NUMIDA REICHENOWI Grant.

Numida reichenowi GRANT, Ibis, 1894, p. 536 (Makarungu, Ukambani District, British East Africa).

One apparently typical specimen, from East Africa, but without specific data.

NUMIDA INTERMEDIA (Neumann).

Numida murungensis intermedia NEUMANN, Ornith. Monatsber., 1898, p. 21 (west shore of Victoria Nyanza, German East Africa).

One adult male, from the plains of Taveta, July 2, 1888. This is a typical specimen, answering perfectly to the descriptions of *N. intermedia*, and considerably extends the range of the species which does not seem previously to have been recorded except from the vicinity of Lake Victoria Nyanza.

ACRYLLIUM VULTURINUM (Hardwicke).

Numida vulturina HARDWICKE, Proc. Zool. Soc. Lond., 1834, p. 52 (coast of western Africa).

Two specimens, from Mount Kilimanjaro, and the plains east of that mountain, respectively. Both are adults in fine plumage.

Family OTIDIDÆ.

LOPHOTIS GINDIANA (Oustalet).

Eupodotis gindiana OUSTALET, Bull. Soc. Philom. Paris, 1881, p. 164 (Somali Land).

One specimen from the plains east of Mount Kilimanjaro, September 22, 1888. This is an immature male, and seems to agree very well with the description of the adult female, though we have no proper specimens for comparison.

LISSOTIS MELANOASTRA (Rüppell).

Otis melanogaster RÜPPELL, Neue Wirb. Fauna Abyss., Vögel, 1835, p. 16, pl. vii (Zana Lake, Dembea, Abyssinia).

Otis melanogaster RÜPPELL, Mus. Senckenb., II, 1837, p. 240.

Lissotis locati GRANT, Bull. Brit. Orn. Club, X, 1900, p. xxxix (Bilo, Abyssinia).

Two specimens: an adult female from the plains east of Mount Kilimanjaro, September 19, 1888; and an adult male without data. "Iris of female yellow; legs and feet white." The wing pattern of the adult female in this species is very similar to that of the immature male.

Both of Doctor Abbott's birds belong to the species with much white on the wings, which was named *Lissotis locati*^a by Mr. Grant, but which is, unfortunately, also the true *Lissotis melanogaster* of Rüppell,^b as may easily be seen by consulting the original plate and descriptions.^b Rüppell clearly and at considerable length characterizes the bird with large white wing areas, and gives also a plate which unequivocally represents the same species. Furthermore, Rüppell's type came from Abyssinia, where, according to Mr. Grant,^c the black-winged bird is not found at all, but where the white-winged one is of regular and common occurrence. From these facts it appears that the form with wings largely black, found in Natal^d and elsewhere in southern Africa, figured by Mr. Grant,^e is without a name; and, as it seems to be a perfectly distinct species, may be called:

Lissotis notophila, new species.

The characters and geographical distribution of the two species have been so fully and so carefully marked out by Mr. Grant that repetition of these in the present connection is quite unnecessary, but for this information his various publications on the subject should be consulted.^f

EUPODOTIS KORI (Burchell).

Otis kori BURCHELL, Trav. S. Afr., I, 1822, pp. 393, 402 (mouth of Vaal River, Griqualand West, South Africa).

Two specimens, male and female, from the Useri River, east of Mount Kilimanjaro. The center of the crown is more brownish, less slaty in the female than in the male. "Iris of male light yellowish brown."

^a Bull. Brit. Orn. Club, X, 1900, p. xxxix.

^b Neue Wirb. Fauna Abyss., Vögel, 1835, p. 16, pl. vii; Mus. Senckenb., II, 1837, p. 240.

^c Ibis, 1902, pp. 456-457.

^d Durban, Natal, may be considered the type locality.

^e Ibis, 1902, p. 455, fig. 11.

^f Bull. Brit. Orn. Club, X, 1900, p. xxxix; Ibis, 1900, pp. 326-327; 1901, pp. 688-689; 1902, pp. 453-457, pl. xi.

Family HELIORNITHIDÆ.

PODICA SENEGALENSIS PETERSII (Hartlaub).

Podica petersii HARTLAUB, Abhandl. Nat. Ver. Hamburg, II, 1852, p. 62 (Mozambique, eastern Africa).

One specimen from the Lumi River, near Taveta, November 30, 1888. "Iris brown; feet red; bill red, excepting a black line along the culmen." It is of large size, and in this, as otherwise, bears out the characters accredited to *petersii* as distinguished from *senegalensis* proper.

Family JACANIDÆ.

ACTOPHILUS AFRICANUS (Gmelin).

Parra africana GMELIN, Syst. Nat., II, ii, 1788, p. 709 (Africa).

Three specimens—one adult, two immature—from Aruscha-wachini, south of Mount Kilimanjaro, October 26, 1889. The frontal shield is much larger in the adult than in the immature bird. "Iris of adult brown; frontal plate light blue; feet slate color. Iris of immature (male and female) brown; frontal plate light green; feet greenish-slate color."

Family CHARADRIIDÆ.

HOPLOPTERUS SPECIOSUS (Wagler).

Charadrius speciosus WAGLER, Isis, 1829, p. 649 (from Lichtenstein, in Mus. Berol.) (Kaffir Land, South Africa).

Three specimens: one from the Useri River, near Mount Kilimanjaro; the two others without data, but probably from the same or a neighboring locality. In one of these birds there is a broad band of pearl gray below and bordering the black of the breast; and in another there is an indication of the same.

STEPHANIBYX CORONATUS (Boddaert).

Charadrius coronatus BODDAERT, Tabl. Pl. Enlum., 1783, p. 49 (Cape of Good Hope, South Africa).

Two specimens, male and female, from the plains of Lake Jipé, taken May 19, 1888, agree with a specimen in the United States National Museum from Uitenhage, Cape Colony. "Numerous on the dry plain."

OCHTHODROMUS ASIATICUS (Pallas).

Charadrius asiaticus PALLAS, Reis. Russ. Reichs, II, 1773, p. 715 (southern Tartary).

Three specimens, from the plains east of Mount Kilimanjaro, September 30, 1888. All are immature, and in two of them the broad brownish breast band is rather obscurely defined. "Legs (of male) greenish."

Family SCOLOPACIDÆ.

RHYACOPHILUS GLAREOLA (Linnæus).

Tringa glareola LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 149 (Europe [type locality, Sweden]).

Two specimens: one from the plains of Mount Kilimanjaro, August 25, 1888; the other from the plains east of the same mountain, December 8, 1888. "Feet greenish." The former is not yet fully molted, this particularly noticeable on the anterior upper parts; and furthermore it has the breast and jugulum medially white with only faded brownish streaks.

The generic term *Rhyacophilus*^a is the proper one for the present species, whether or not *Helodromas*^b be held as distinct; for *Rhyacophilus*, though published in the same work, occurs on a previous page. Hence if *Helodromas* be united to *Rhyacophilus* the latter becomes the proper name for the whole group. There seems, however, to be sufficient reason for the generic separation of *Helodromas ochropus* from *Rhyacophilus glareola*, since in the former the tarsus is equal to the culmen, or less, and the middle toe is less than the culmen; while in the latter species the tarsus and middle toe each exceed the culmen. The characters that distinguish *Rhyacophilus* from *Totanus* are as follows: Tail about equal to combined length of tarsus and middle toe with claw, instead of much shorter; middle toe with claw but little shorter than tarsus, in place of being only about two-thirds as long; feet when extended reaching but little beyond the tail, instead of far beyond.

But with *Rhyacophilus glareola* must be associated *Tringa solitaria* Wilson, for a careful comparison fails to reveal any structural difference, although the latter frequently has been considered congeneric with *Helodromas ochropus* and generically separable from *Rhyacophilus glareola*. Thus we shall have:

Helodromas ochropus (LINNÆUS).

Rhyacophilus glareola (LINNÆUS).

Rhyacophilus solitarius solitarius (WILSON).

Rhyacophilus solitarius cinnamomens (BREWSTER).

ACTODROMAS MINUTA (Leisler).

Tringa minuta LEISLER, Nachtr. Bechsteins Naturg. Deutschl., I, 1812, p. 74 (Hanau, Germany).

One example, from the Usuri River, on the plains of Mount Kilimanjaro, August 27, 1888. This is an adult female not yet completely molted into winter plumage.

^a Kaup, Skizz. Entw.-Gesch. Eur. Thierw., 1829, p. 140 (type, *Tringa glareola* Linnæus).

^b Kaup, idem, p. 144 (type, *Tringa ochropus* Linnæus).

I am unable to discover any characters by which the so-called genera *Leimonites*^a (= *Actodromas*^b) and *Heteropygia*^c can be satisfactorily distinguished from each other, and they therefore must be united. For this combination the first name in nomenclatural precedence is *Leimonites*, which is several pages anterior to *Actodromas*; but it is untenable by reason of *Limnitis* Dalman,^d a genus of Lepidoptera, and consequently should give way to *Actodromas*.

GALLINAGO MEDIA (Latham).

Scolopax media LATHAM, Gen. Syn. Suppl., I, 1787, p. 292 (Kent, England).

Scolopax major GMELIN, Syst. Nat., I, ii, 1788, p. 661 (England).

One adult male, from Mount Kilimanjaro, at 8,000 feet, November 20, 1888.

The correct name for this species is, as already has been pointed out,^e *Gallinago media* (Latham), since this has one year's priority over *Scolopax major* Gmelin.

Family RECURVIROSTRIDÆ.

HIMANTOPUS HIMANTOPUS (Linnæus).

Charadrius himantopus LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 151 (southern Europe).

One specimen, from the plains east of Mount Kilimanjaro, December 8, 1888. It is an immature female with gray head and hind neck. "Iris orange; feet flesh color."

Family CURSORIIDÆ.

RHINOPTILUS BISIGNATUS (Hartlaub).

Cursorius bisignatus HARTLAUB, Proc. Zool. Soc. Lond., 1865, p. 87 (Benguela, southwestern Africa).

Two adults from Taveta are in the collection. The form described by Doctor Sharpe from Somali Land, *Rhinoptilus bisignatus hartingi*,^f is apparently an excellent race. An example of the latter in the United States National Museum has, in addition to the characters mentioned in descriptions, the throat and particularly the sides of the head paler, more whitish than in true *bisignatus*.

^a Kaup, Skizz. Entw.-Gesch. Eur. Thierw., 1829, p. 37 (type, *Tringa temminckii* Leisler).

^b Kaup, idem, p. 55 (type, *Tringa minuta* Leisler).

^c Coues, Proc. Acad. Nat. Sci. Phila., 1861, p. 190 (type, *Tringa bonapartii* Schlegel = *Tringa fuscicollis* Vieillot).

^d Kgl. Vet.-Akad. Handl., 1816, p. 55.

^e Oberholser, Auk, 1899, p. 179.

^f *Rhinoptilus hartingi* SHARPE, Bull. Brit. Orn. Club, III, 1893, p. xiv (Somali Land).

RHINOPTILUS CHALCOPTERUS (Temminck).

Cursorius chalcopterus TEMMINCK, Pl. Col., V, 1824, pl. CCXCVIII (Senegal).

One specimen from Taveta, March 25, 1888. "Legs red; iris very dark brown."

RHINOPTILUS CINCTUS (Heuglin).

Hemerodromus cinctus HEUGLIN, Ibis, 1863, p. 31, pl. 1 (Gondokoro, White Nile, 5° N. Lat., British Equatorial Africa).

Two specimens, from Taveta, and the plains east of Mount Kilimanjaro, respectively. They apparently do not differ from a Somali Land example.

Family ŒDICNEMIDÆ.

ŒDICNEMUS CAPENSIS Lichtenstein.

Oedicnemus capensis LICHTENSTEIN, Verz. Doubl., 1823, p. 69 (Cape of Good Hope).

Two examples, from the plains east of Mount Kilimanjaro. One of these, a male, taken July 13, 1889, is much paler than the other and seems to be immature. "Iris (of adult female) yellow." "Common on the dry plains; almost always seen in pairs."

Whether or not Doctor Reichenow is correct in his contention that *Œdicnemus affinis* is inseparable from *Œdicnemus capensis*,^a there is no doubt that the specimens collected by Doctor Abbott are strictly referable to the latter.

Family PTEROCLIDÆ.

PTEROCLURUS EXUSTUS (Temminck).

Pterocles exustus TEMMINCK, Pl. Col., V, 1825, pls. CCCLIV, CCCLX (Senegal).

One apparently typical specimen, without data.

A specimen in the National Museum from Milmil, Somali Land, collected July 30, 1894, by Dr. A. Donaldson Smith, sustains the characters of Mr. Hartert's new subspecies, *Pteroclorus exustus somalicus*,^b except that it is not smaller than our examples of true *exustus*.

PTEROCLES DECORATUS Cabanis.

Pterocles decoratus CABANIS, Journ. f. Ornith., 1868, p. 413 (Lake Jipé, German East Africa).

One adult female, from the plains near Mount Kilimanjaro, August 29, 1888.

^a Vögel Africas, I, 1900, p. 199.

^b *Pterocles exustus somalicus* HARTERT, Novit. Zool., 1900, p. 28 (Milmil, Somali Land).

PTEROCLES GUTTURALIS SATURATION Hartert.

Pterocles gutturalis saturation HARTERT, Novit. Zool., 1900, p. 29 (Campi-ya-Simba, British East Africa).

Two adult males: one from the plains east of Mount Kilimanjaro, September 23, 1888; the other from the plains of Kilimanjaro, August 21, 1888. The black bars on some of the lower tail-coverts, which are present in both these specimens, seem to be nothing more than an individual variation.

Family TRERONIDÆ.

VINAGO CALVA WAKEFIELDI (Sharpe).

Treron wakefieldi SHARPE, Proc. Zool. Soc. Lond., 1873, p. 715, pl. LVIII, fig. 2 (Mombasa, British East Africa).

Two specimens, adult male and female, from Mount Kilimanjaro, at 5,000 feet, September 1, 1889. "Iris (of both) white; bill whitish; cere light orange; feet dark red." The female is smaller than the male, also darker and duller colored, with a much less pronounced plumbeous hind-neck, and a grayish green instead of greenish slate-gray tail. These two birds are not typical of *wakefieldi*, being larger and having tails that incline to slate grayish; but they are apparently much nearer this form than to *Vinago calva nudirostris*; they furthermore present in their intermediate characters almost indisputable evidence that *wakefieldi* is but a subspecies of *V. calva*, and therefore its easternmost representative. There are thus four forms of *Vinago calva*, as follows:

Vinago calva calva (Temminck and Knip).—West Africa, from Sierra Leone to Angola.

Vinago calva nudirostris (Swainson).—Central Africa and the interior of East Africa, north of the Zambesi River; northwest to Senegal.

Vinago calva wakefieldi (Sharpe).—Coast region of East Africa, from southern British East Africa to the Zambesi River.

Vinago calva schalowi (Reichenow).—South Africa, from Matabele Land to Ovambo Land.

Family COLUMBIDÆ.

COLUMBA ARQUATRIX ARQUATRICULA (Bonaparte).

Columba arquatrix BONAPARTE, Consp. Avium, II, 1854, p. 50 (Abyssinia).

Two specimens, adult male and female, from Mount Kilimanjaro, at 6,000 and 5,000 feet, respectively. The male, taken November 10, 1888, is in nearly completed molt. "Iris white; bill and feet bright yellow."

These differ so much from true *Columba arquatrix* of southern Africa^a that they represent without apparent doubt a well character-

^aTemminck and Knip, Pigeons, I, 1808, fam. sec., p. 11, pl. v (Cape of Good Hope).

ized geographical race, to which Bonaparte's name *arquatrix* is probably applicable. This northern form may be distinguished by decidedly larger size, as well as by smaller, much less numerous spots on the lower surface, and these confined chiefly to the upper breast, whereas in *arquatrix* they are spread as thickly over also the lower breast and median portion of the abdomen. The following measurements of an adult female of each exhibit the dimensional difference between these two subspecies:

Name.	Locality.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
<i>Columba arquatrix arquatrix</i> ...	Uitenhage, Cape Colony ..	mm. 203	mm. 135	mm. 19	mm. 28	mm. 30
<i>Columba arquatrixarquatrix</i> ..	Mount Kilimanjaro	238	152	18	28	30

TURTUR LUGENS (Rüppell).

Columba lugens RÜPPELL, Neue Wirb. Faun. Abyss., Vogel, 1835, p. 64, pl. XXII, fig. 2 (Taranta Mountains, Tigré; and province of Simen, Abyssinia.)

One adult male, from Mount Kilimanjaro, 5,000 feet, taken July 24, 1888. "Iris orange."

TURTUR SEMITORQUATUS INTERMEDIUS Erlanger.

Turtur semitorquatus intermedius ERLANGER, Journ. f. Ornith., 1905, p. 124 (Roba-Schalo, Lake region of southern Shoa, southern Abyssinia.)

Two adult males, from Taveta and Mount Kilimanjaro. "Iris orange." These belong apparently to this newly described form which seems, however, to be very close to *Turtur semitorquatus semitorquatus*.

TURTUR CAPICOLA TROPICUS Reichenow.

Turtur capicola tropica REICHENOW, Ornith. Monatsber., 1902, p. 139 (East Africa).

Two specimens, from Taveta, and the plains east of Mount Kilimanjaro, respectively. Doctor Abbott reported it abundant during April, 1888, on the plains near Taveta. The adult female collected by him is considerably smaller than the male, as well as decidedly paler, especially on the breast, cervix, and sides of the neck, which parts are more of a lavender hue; the forehead and crown are heavily overlaid with dull ochraceous buff; the chin is less purely white.

This appears to be a good race, differing from true *capicola* chiefly in its lighter general coloration, the pallor particularly noticeable on wings and lower parts. It was made a subspecies of *Turtur damarensis* Finsch and Hartlaub^a by Erlanger,^b but improperly so, as the conspecific *Turtur capicola* Sundevall^c was described long before.

^a Vög. Ost.-Afr., 1870, p. 550.

^b Journ. f. Ornith., 1905, p. 123.

^c Krit. om Levaill., 1857, p. 54.

The genus *Streptopelia* seems not to be sufficiently distinct for recognition, since aside from slight color distinctions it has no stable characters that we can discover.

STIGMATOPELIA SENEGALENSIS ÆQUATORIALIS (Erlanger).

Turtur senegalensis æquatorialis ERLANGER, Journ. f. Ornith., 1905, 117 (Menaballa, southern Abyssinia).

Three specimens, from Taveta, and the Useri River, Mount Kilimanjaro. These are all females, and are somewhat smaller than the male of the species, as well as decidedly duller in color, this difference greatest on the back and cervix.

The peculiar bifurcated feathers of the foreneck, and the greater graduation of the tail in this species appear to warrant recognition of the genus *Stigmatopelia*.

TYMPANISTRIA TYMPANISTRIA (Temminck and Knip).

Columba tympanistria TEMMINCK and KNIP, Pigeons, I, 1809, fam. sec., p. 80, pl. xxxvi (southern Africa, near Kaffir Land).

Two specimens, from Mount Kilimanjaro, at 5,000 feet. The immature bird differs as follows from the adult: Upper surface of the body more rufescent; forehead grayish, slightly tinged with tawny; crown washed, the back and rump barred, with rusty; wing-coverts and secondaries duller, as well as rather paler, with mottlings and some bars of dark brown and tawny, the secondaries with a dark subterminal bar; sides of the head shaded with ashy and brownish; anterior lower parts more or less barred with dark brown and ochraceous; lower tail-coverts with tips and sometimes bars of tawny.

ÆNA CAPENSIS ANONYMA, new subspecies.

Chars subsp.—Similar to *Æna capensis capensis*, but all the upper parts paler, decidedly more grayish, the whitish band (between the two blackish ones) on the rump less tinged with ochraceous; white on outer web of outermost tail feather not subterminally interrupted by black, but continuous; inferior-wing-coverts lighter chestnut.

Description.—Type, adult male, Cat. No. 117868, U.S.N.M.; plains east of Mount Kilimanjaro, December 11, 1888; Dr. W. L. Abbott. Upper surface brownish gray, paler anteriorly, becoming pearl gray on the fore part of the crown; rump crossed by two blackish bands inclosing a rather wider one of grayish white washed with buffy; longest upper tail-coverts with broad blackish tips; tail black beneath; middle pair of rectrices brownish slate color above; the next two pairs slate color, with broad blackish terminal portions; remaining feathers slate color, with a subterminal band of black, the outermost pair with external webs largely white; wings chestnut, the primary coverts margined exteriorly and tipped with blackish, the quills with fuscous;

lesser and median coverts plumbeous, the inner ones of the latter series with metallic green or purple spots; greater coverts slate gray, with broad blackish tips; innermost secondaries (tertials) brownish gray; forehead, lores, chin, and throat black; sides of neck pale brownish gray; sides of jugulum pearl gray; rest of lower surface white, except the crissum, which is mostly black; lining of wing chestnut. Length of wing, 104; tail, 132; exposed culmen, 14; tarsus, 13; middle toe, 13 mm.

An adult female, taken at the same time and place as the type, has a dusky bill, and is rather paler, more brownish, both above and below, lacking, of course, all the black of head and throat, this being replaced on forehead and chin by pale buff, on the throat by grayish ochraceous. Compared with the female of the South African form it exhibits the same subspecific characters as the male, except that there is no difference in the distribution of the white on the outermost rectrices.

This northern race of *Ena capensis* has apparently hitherto remained unnoticed, since all the names applied to the species^a have been based on the bird from southern Africa. Its exact distribution remains yet to be determined, for the above comparison has been made with birds from Cape Colony alone, but in all probability *Ena e. anonyma* occupies the region to the southward as far as the neighborhood of the Zambesi River.

CHALCOPELIA AFRA (Linnæus).

Columba afra LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 284 (Senegal).

Four specimens, from Mount Kilimanjaro, at 5,000 feet altitude. One of them, an adult, taken April 20, 1888, is in molt. The sexes seem to be practically alike, the only observable difference being the barely paler color and slightly smaller size of the female. An immature bird, however, is more rufescent on the back, cervix, and scapulars; the secondaries, except the innermost, are paler, mottled with dusky on their exterior webs, tipped with tawny or ochraceous, and have a subterminal fuscous bar; the forehead is pale buff, the crown washed with the same color; the sides of head and neck, together with the entire lower surface, excepting the crissum, are strongly tinged with ochraceous; the lower parts, save the middle of the abdomen, have obsolete dusky bars, these most conspicuous on the sides and flanks; the edge of the wing is also barred with blackish.

Even so recent and discriminating an authority as Doctor Reichenow^b

^a These are:

Columba capensis Linnæus, Syst. Nat., 12th ed., I, 1766, p. 286 (Cape of Good Hope).

Columbe atricollis Müller, Syst. Nat. Suppl., 1776, p. 135 (Cape of Good Hope).

Columba atrogularis Wagler, Syst. Avium, 1827 (*Columba*, sp. 108), p. 270 (new name for *Columba capensis*).

^b Vögel Africas, I, 1901, p. 426.

used to consider *Chalcopelia chalcospila* (Wagler)^a identical with the present species; but he has changed his mind,^b and now agrees that Erlanger is undoubtedly quite right in asserting their distinctness.^c As the latter says, their occurrence in the same locality precludes the possibility of their being but geographical races; and in connection with this it may be stated as further proof that there are no specimens that can be considered of an intermediate character. Aside from an interesting difference in habits noted by Mr. Erlanger—*chalcospila* living among the acacias on the plains, and *afra* more confined to the forests—these two species may be distinguished as follows: *Chalcopelia afra* is much larger; it has blue or purple instead of bright-green metallic spots on the inner wing-coverts; the bill is yellow instead of almost black; the brown area of the entire upper surface is decidedly more rufescent; and the chin, as well as the cheeks, flanks, and abdomen, are strongly tinged with buff.

None of the specimens collected by Doctor Abbott approach either of the forms recently described by Doctor Sharpe,^d but are all apparently typical *afra*.

CHALCOPELIA CHALCOSPILA ACANTHINA, new subspecies.

Chars. subsp.—Similar to *Chalcopelia chalcospila chalcospila*, but larger; very much paler below; somewhat lighter above, particularly on the wings.

Description.—Type, adult female, Cat. No. 119253, U.S.N.M.; Mount Kilimanjaro, German East Africa, 5,000 feet, December 6, 1889; Dr. W. L. Abbott. Forehead pale gray, laterally whitish, and passing posteriorly into the slate gray of the crown and occiput, both of which are paler laterally; orbital region pale gray; a narrow blackish line from eye to bill; cervix, back, and scapulars grayish brown; rump with two bands of black inclosing one of pale brownish; upper tail-coverts like the back, but slightly paler and more grayish, the feathers with broad black tips; tail black below, dull brownish gray above, with a broad black terminal band, the outermost feathers slate gray basally, with outer webs whitish, this succeeded distally by a broad zone of black which in turn gives place to a slate-colored tip, paler on exterior web; wing-quills chestnut, margined exteriorly and broadly tipped with dark brown, some of the inner secondaries entirely of this color; alula blackish brown; primary-coverts chestnut with wide outer margins of dark brown; remainder of wing-coverts,

^aSyst. Avium, 1827 (*Columba*, sp. 83), p. 258.

^bJourn. f. Ornith., 1902, p. 134.

^cOrnith. Monatsber., 1901, p. 183.

^d*Chalcopelia abyssinica* Sharpe, Bull. Brit. Orn. Club, XII, 1902, No. xc, p. 83 (Kokai, Bogos Land, Abyssinia). *Chalcopelia delicatula* Sharpe, idem, p. 84 (Goz-Abu-Gumar, White Nile).

together with the innermost secondaries, brownish gray, the latter and some of the inner greater coverts with large spots of rich metallic golden green; under surface vinaceous lavender, on the sides of neck shading into the brownish of the upper parts, and fading posteriorly into almost pure white on the anal region, the chin whitish, the flanks tinged with brownish, the longer under tail-coverts mostly black; lining of wing chestnut. "Iris brown; feet dark purple; bill dark horn blue, nearly black."

Measurements of the type compared with two specimens of true *chalcospila* from western Africa are as follows:

Sex.	Name.	Locality.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
			mm.	mm.	mm.	mm.	mm.
Female..	<i>Chalcopelia chalcospila acanthina.</i>	Mount Kilimanjaro ..	104	75	13	18	16.5
?	<i>Chalcopelia chalcospila.</i>	Landana	99	72.5	13	18	15.5
?	do	Massabi	96.5	62	13	18	16

The original *Chalcopelia chalcospila*^a was based on "La Tourterelle du Sénégal (*Turtur senegalensis*)" of Brisson^b as is shown by Wagler's citations, and particularly his description which in all essential particulars is identical, except for its verbal construction, with that of Brisson;^c and the form of the species to bear the name *chalcospila* is therefore that from western Africa. The only other old name that needs mention here is *Peristera parallinostigma* Würtemberg,^d which, however, is but a renaming of *Chalcopelia chalcospila*, and therefore not available for any of its races.

The present comparison has been made with birds from near the mouth of the Kongo, which are probably the same as true *chalcospila* from Senegal, since in measurements and color characters they agree with the original account; and they are, moreover, doubtless identical with *Chalcopelia chalcospila erlangeri*^e from northern Angola, which Doctor Reichenow described under the supposition that the East African form was the typical one, in which he was, of course, mistaken, as above shown; so that unless *C. c. erlangeri* can be proved distinct from the Senegal bird it must be entered as a synonym. The Somali Land race, *Chalcopelia chalcospila somalica* Erlanger,^f is apparently

^a *Columba chalcospilos* Wagler, Syst. Avium, 1827 (*Columba*, sp. 83), p. 258 (Senegal).

^b Ornith., I, 1760, p. 122, pl. x, fig. 1 (Senegal).

^c It may be noted in this connection that Linnæus (Syst. Nat., 12th ed., I, 1766, p. 284) quotes this same name of Brisson's under his *Columba afra*, though his diagnosis is perfectly clear and refers to the bird with blue or purple wing spots (*Chalcopelia afra*).

^d Naumannia, 1857, p. 434.

^e Reichenow, Journ. f. Ornith., 1902, p. 134.

^f Journ. f. Ornith., 1905, p. 134 (Salakle, southern Somali Land).

good, differing from *acanthina* of East Africa in its larger size, rather paler upper parts, and much darker, more pinkish lower surface.

There seem thus to be five forms of *Chalcopelia chalcospila*, as follows:

Chalcopelia chalcospila chalcospila (Wagler) (= *erlangeri* Reichenow).—West Africa from Senegal to Angola.

Chalcopelia chalcospila volkmanni Reichenow.^a—Damara Land.

Chalcopelia chalcospila caffra Reichenow.^b—Southeastern Africa.

Chalcopelia chalcospila acanthina Oberholser.—East and Northeast Africa, excepting Somali Land.

Chalcopelia chalcospila somalica Erlanger.—Somali Land.

APLOPELIA LARVATA LARVATA (Temminck and Knip).

Columba larvata TEMMINCK and KNIP, Pigeons, I, fam. sec., 1809, p. 71, pl. xxxi (Autiniquoi country, southern Africa).

Seven specimens from Mount Kilimanjaro, at altitudes of 5,000 and 6,000 feet. Those taken June 8–12, 1888, were just completing the molt. A young bird in the barred plumage bears date of June 10, 1888.

These examples are appreciably smaller than typical *A. larvata* from southern Africa, in this verging toward *Aplopelvia larvata bronzinga*, but they are still much too large for the latter. Size, however, seems to be the only particular in which these birds differ from true *larvata*, and this is so slight that the recognition of another subspecies (*kilimensis*)^c is apparently not desirable. The characters given in the original description of *kilimensis*^c are probably based on individual variation, for they are not borne out by Doctor Abbott's Kilimanjaro specimens. This is also the view taken by Doctor Reichenow,^d who synonymizes *kilimensis* with *larvata*, and states that South Africa specimens do not differ from those taken on Kilimanjaro. Furthermore Doctor Reichenow is apparently right in considering *Aplopelvia johnstoni*^e a synonym of *A. larvata*.^f Our birds certainly do not exhibit the characters assigned to this supposed form.

Family CUCULIDÆ.

CLAMATOR CAFER (Lichtenstein.)

Cuculus cafer LICHTENSTEIN, Cat. rer. nat. Hamb., 1793, p. 14 (Kaffir Land).

Coccytes cafer AUTHORS.

One adult male, from Kidudwe, 90 miles inland from Zanzibar, December, 1887.

^a Journ. f. Ornith., 1902, p. 134 (Damara Land).

^b Idem, 1902, p. 134 (Caffraria, southeastern Africa).

^c *Haplopelvia larvata kilimensis* Neumann, Journ. f. Ornith., 1898, p. 289 (Kiboscho, Mount Kilimanjaro).

^d Vogel Africas, I, 1901, pp. 420–421.

^e *Haplopelvia johnstoni* Shelley, Ibis, 1893, p. 28, pl. iii (Milanji Plateau, Nyassa Land, British Central Africa).

^f Vogel Africas, I, 1901, p. 421.

The change in the generic name of this species is due to Dr. L. Stejneger,^a who has recently pointed out the untenability of *Coccytes* by reason of the prior *Clamator*.

CUCULUS CLAMOSUS Latham.

Cuculus clamorus LATHAM, Ind. Orn., Suppl., 1801, p. xxx (Cape of Good Hope).

One young female, with wings and tail not yet fully grown, from Mount Kilimanjaro (5,000 feet), November 19, 1889. This bird differs in appearance somewhat from the published accounts of young *Cuculus clamorus*, and may be described as follows:

General color above black, inclining to dark brown on the wings, the feathers slightly but distinctly margined with whitish, those of the wings with tawny ochraceous; chin, throat, fore breast, with sides of head and neck black, the feathers narrowly edged with whitish; feathers of the fore breast and sides of neck with more or less concealed bars of white; lower breast and abdomen buff with black bars, the latter becoming narrower on thighs and lower tail-coverts; under wing-coverts buff, mottled and barred with blackish; primaries mottled on inner webs with dull tawny white or ochraceous; rectrices black with a central white shaft spot toward the end of each feather, and with buffy white terminal markings. "Feet straw yellow."

CHRYSOCOCCYX KLAAS (Stephens).

Cuculus klaas STEPHENS, Shaw's Gen. Zool., IX, 1815, p. 128 (Senegal).

A single adult male, from Taveta, August 17, 1888. It is much smaller, and strikingly more bronzy green on the upper surface than an adult of the same sex from Cape Colony.

CENTROPUS SUPERCILIOSUS Hemprich and Ehrenberg.

Centropus superciliosus HEMPRICH and EHRENBURG, Symb. Phys., 1828, fol. r (Arabia and Æthiopia [type locality, southern Arabia]).

Three specimens, from Taveta and Mount Kilimanjaro (5,000 feet). "Iris of male red, of female dark carmine. Length of female, 16¾ inches [426 mm.]; extent, 20 inches [508 mm.]."

The two males are much smaller than the female, and have, moreover, dusky bars on the distal portion of all the wing-quills, an apparent indication of recent youth, though in all other respects they are precisely like the adult.

^aProc. Biol. Soc. Wash., XV, 1902, p. 37.

Family MUSOPHAGIDÆ.

TURACUS HARTLAUBI (Fischer and Reichenow).

Corythaix hartlaubi FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 52 (base of Mount Meru, Masai Land, German East Africa).

Eight specimens, from Mount Kilimanjaro, at altitudes of from 4,000 to 7,000 feet. An immature bird differs from the adult in the somewhat duller and darker green of the plumage; brownish-black abdomen and crissum; smaller and less purely white loreal spot; dark brownish bill; and the paler, decidedly more restricted crimson of the wing-quills.

GALLIREX CHLOROCHLAMYS Shelley.

Gallirex chlorochlamys SHELLEY, Ibis, 1881, p. 118 (Ugogo, German East Africa).

One adult specimen from Kidudwe, 90 miles inland from Zanzibar, December, 1887.

CHIZÆRHIS LEUCOGASTRA Rüppell.

Chizærhis leucogaster RÜPPELL, Mus. Senckenb., III, 1842, p. 127 (tributaries of the Nile, Shoa, Abyssinia).

Two adult females: one from the plains of Taveta; the other from the Useri River, near Mount Kilimanjaro. "Bill yellowish green; iris brown."

Family PSITTACIDÆ.

POICEPHALUS FUSCICAPILLUS (Verreaux and Des Murs).

Pionus fuscicapillus VERREAUX and DES MURS, Rev. et Mag. de Zool., 1849, p. 58 (Zanzibar, eastern Africa).

Two specimens from Kidudwe, 90 miles inland from Zanzibar, taken in December, 1887. Both are immature, one having an olive green pileum and brown auriculars, the other a yellowish olive brown head, and auriculars just becoming grayish.

POICEPHALUS RUFIVENTRIS (Rüppell).

Pionus rufiventris RÜPPELL, Syst. Uebers. Vög. Nord-Ost-Afr., 1845, p. 83, pl. XXXII (Shoa, Abyssinia).

Four specimens—three adult males and an adult female—from Taveta, and the plains east of Mount Kilimanjaro. "Iris of both male and female red."

Family CORACIIDÆ.

CORACIAS GARRULUS Linnaeus.

Coracias garrulus LINNAEUS, Syst. Nat., 10th ed., I, 1758, p. 107 (Europe [type locality, Sweden]).

Seven specimens: two are without data; the others were taken at Taveta, March 25, 1888; Mount Kilimanjaro, 5,000 feet altitude, October 20, 1889; and the Useri River, Mount Kilimanjaro, December 14 and 18, 1888. "Irides of young brown. Very common now (December 18, 1888), after an absence of seven months." One of the immature birds, taken December 18, is just completing a molt of the wing quills.

CORACIURA CAUDATA (Linnaeus).

Coracias caudata LINNAEUS, Syst. Nat., 12th ed., I, 1766, p. 160 (Angola).

Two specimens: an adult male from the plains east of Mount Kilimanjaro; and a female from the plains near Taveta.

The remarkable development of the tail in the male of this and several similar species seems to entitle them to the generic distinction founded by Bonaparte on *Coracias cyanogaster*.^a

EURYSTOMUS AFER SUAHELICUS Neumann.

Eurystomus afer suahelicus NEUMANN, Journ. f. Ornith., 1905, p. 186 (Tschara, Tana River, British East Africa).

Three adult specimens, all from Taveta. One of them, a female, measures as follows: Length of wing, 181; tail, 99; exposed culmen, 21; tarsus, 17; middle toe, 18 mm.

This recently described form differs from true *Eurystomus afer* in its decidedly larger size, and appreciably darker, more rufous lower surface. Doctor Sharpe long ago called attention^b to the dimensional discrepancy existing between specimens of *Eurystomus afer* from East and those from West Africa, while Mr. Neumann some time ago noticed^c their darker and more rufescent color. These differences now seem sufficient to warrant recognition in nomenclature; and if Doctor Reichenow's *Eurystomus rufobuccalis*^d is even subspecifically distinct, as appears to be the case, the form of *E. afer* inhabiting the eastern part of Africa should bear the name *suahelicus* Neumann, since

^a *Coraciura* Bonaparte, Consp. Voluer. Anisod., 1854, p. 7.

^b Cat. Birds Brit. Mus., XVII, 1892, p. 31.

^c Journ. f. Ornith., 1900, p. 209.

^d *Eurystomus afer* var. *rufobuccalis* Reichenow, Journ. f. Ornith., 1892, p. 27 (Mankonjo, Uganda, British East Africa).

all the synonyms of the species, as claimed by Neumann, apply without much doubt to the bird of the west coast.^a

Family ALCEDINIDÆ.

CERYLE RUDIS (Linnæus).

Alcedo rudis LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 116 (Persia).

A single adult, from the Useri River, Mount Kilimanjaro, December 15, 1888. This bird, though marked "male," has but one black pectoral band, a circumstance which, borne out as it is by our other specimens from various localities, serves to strengthen the doubt Doctor Reichenow has expressed^b with regard to this supposed sexual distinction.

ALCEDO SEMITORQUATA Swainson.

Alcedo semitorquata SWAINSON, Zool. Illustr., III, 1823, pl. CLI (Great Fish River, Cape Colony, South Africa).

Two specimens—adult male and female—from Taveta. "Feet (of male) red; bill black, with a red streak on the under side." The female of this pair is slightly larger than the male, also somewhat duller in color above, particularly on the wings, and appreciably darker on the posterior part of the lower surface; the appearance of the base of the maxilla in the skin indicates that this part was red in life.

ISPIDINA PICTA (Boddaert).

Todus pictus BODDAERT, Tabl. Pl. Enl., 1783, p. 49 (Juida, Africa.)

Three adult males, from Taveta, and Mount Kilimanjaro (5,000 feet). These are apparently identical with an example from Somali Land. "Bill and feet red."

HALCYON SEMICÆRULEUS SEMICÆRULEUS (Forskål).

Alcedo semicærulea FORSKÅL, Deser. Anim., 1775, p. 2 (Yemen, Turkey in Asia).

Three specimens, from the plains east of Mount Kilimanjaro. "Bill and feet red." These agree perfectly with birds from Somali Land, thus showing no approach to *Halcyon semicæruleus hyacinthinus* Reiche-

^a*Coracias afra* Latham, Ind. Orn., I, 1790, p. 172 (Africa).

Coracias africana Shaw and Nodder, Nat. Misc., XI, 1799, pl. cccci (new name for *E. afer*).

Eurystomus rubescens Vieillot, Nouv. Dict. d'Hist. Nat., XXIX, 1819, p. 426 (new name for *E. afer*).

Eurystomus purpurascens Vieillot, Nouv. Dict. d'Hist. Nat., XXIX, 1819, p. 427 (Senegal).

Colaris viridis Wagler, Syst. Avium, 1827 (*Colaris*, sp. 5), p. 107 (Senegambia).

^bVögel Africas, II, 1903, p. 296.

now. If *Halcyon semicervuleus centralis* Neumann^a is anything more than an individual variation its range certainly does not include the Kilimanjaro region.

HALCYON ALBIVENTRIS ORIENTALIS (Peters).

Halcyon orientalis PETERS, Journ. f. Ornith., 1868, p. 134 (Inhambane, Portuguese East Africa).

Four specimens, from Taveta, and Mount Kilimanjaro (5,000 feet). Both male and female have the "iris dark brown; feet red; bill dark red." One adult male is strongly tinged with ochraceous on the cervical band and on the posterior lower parts. All these individuals have at least faint, dusky shaft streakings on the breast, which are much more conspicuous in the females.

Concerning a pair obtained on Mount Kilimanjaro, Doctor Abbott writes as follows: "These were brought to me alive by natives who had caught them in their nest hole. The stomach of the female was filled with Coleoptera. The nest was 3 feet from the entrance and contained three young birds just hatched."

HALCYON CHELICUTI CHELICUTI (Stanley).

Alauda [sic] *chelicuti* STANLEY, in Salt's Voyage Abyss., App. IV, 1814,^b p. lvi (Chelicut, Abyssinia).

Four specimens: from Taveta; plains of Taveta; and plains of Mount Kilimanjaro. "Common in the dry plains (of Taveta), June 28, 1888." A young bird in first plumage differs from the adults in being more conspicuously tinged with ochraceous on the light portions of the plumage, particularly on the posterior lower surface.

Family MEROPIDÆ.

MELITTOPHAGUS PUSILLUS CYANOSTICTUS (Cabanis).

Merops cyanostictus CABANIS, von der Decken's Reisen, III, 1869, p. 34 (Mombasa, British East Africa; and Dschagga, German East Africa).

Melittophagus sharpei HARTERT, Bull. Brit. Orn. Club, X, 1899, p. xxvii (The Haud, Somali Land).

Six specimens, from the following localities: Mount Kilimanjaro, 5,000 feet; plains east of Mount Kilimanjaro; Kahé, south of Kilimanjaro; and plains of Taveta. There seems to be no plumage difference between the sexes. "Iris red."

Two of these birds—one from Kahé, the other from Mount Kilimanjaro—are perfectly typical *cyanostictus*; but the remainder are variously

^aJourn. f. Ornith., 1905, p. 189 (Bussissi, Victoria Nyanza).

^bQuoted as "1834" by Sharpe, Cat. Birds Brit. Mus., XVII, 1892, p. 239; Shelley, Birds of Africa, I, 1896, p. 117; and Hartert, Novit. Zool., VII, 1900, p. 34. Doctor Reichenow, however, Vögel Africas, II, 1903, p. 271, has it correct.

intermediate between *cyanostictus* and *meridionalis*, the blue line across the forehead being very narrow, in two cases all but obsolete. These differences, moreover, are quite surely not due to age, as the birds are all adults; nor to sex, as the same appear in both male and female. The series as a whole, however, is to be referred decidedly to *cyanostictus*; but, hailing as it does from an intermediate region, demonstrates with apparent conclusiveness that *Melittophagus cyanostictus* is only subspecifically related to *M. meridionalis*; and since *meridionalis* intergrades with *M. pusillus*, the Kilimanjaro form should stand as *Melittophagus pusillus cyanostictus*.

The original description of *Melittophagus cyanostictus*^a was based on specimens from Mombasa and Dschagga—the latter, it will be noticed, practically the same as the locality from which our series comes—both of them places where the green-fronted bird (*meridionalis* Sharpe = *cyanostictus* Hartert, not Cabanis), is not known to occur. Doctor Cabanis, not suspecting, of course, the existence of the two forms *cyanostictus* and *meridionalis*, compared his new species with *Melittophagus pusillus*, or, as he called it, *M. erythropterus*; therefore the fact that he did not specifically mention the presence of the blue frontal band is of comparatively little consequence in determining the identity of the form he was describing. In fact, considered apart, there is nothing at all in the description itself that does not apply equally well to both *cyanostictus* and *meridionalis*, as the following quotation will show:

“Entschiedeneres blaues Superciliarband, ein deutlicher ausgeprägtes schmales schön blaues Halsband als Abschluss der gelben Kehle, merklich breitere schwarze Binde am Flügel und vor der Schwanzspitze.”

Not until several years later^b does Cabanis mention having seen other birds of the same species from Natal and Loango, and that he considered these identical with his original specimens of *cyanostictus* can have little bearing on the case; nor, indeed, is it surprising in view of the great confusion which then existed among the names of birds of this genus, and still less remarkable—in truth, almost inevitable if some of his examples from Dschagga were intermediate, as are those collected by Doctor Abbott. Doctor Sharpe was the first to do the service of extricating these birds from chaos, and he very properly named the green-fronted bird, until then always confounded with true *cyanostictus*, calling it *meridionalis*.^c

The ranges of these two forms are complimentary, as those of geographical races ought to be, and do not overlap, although intermediates of various kinds may be expected in the region of their inosculation,

^a *Merops cyanostictus* Cabanis, von der Decken's Reisen, III, 1869, p. 34.

^b Journ. für Ornith., 1875, p. 340.

^c Cat. Birds Brit. Mus., XVII, 1892, p. 45.

from Zanzibar to Uganda. The blue-fronted form, *Melittophagus pusillus cyanostictus*, extends from Zanzibar and Mount Kilimanjaro to Shoa and Somali Land; the green-fronted bird, *Melittophagus pusillus meridionalis*, occurs from Zanzibar, Uganda, and Loango to Angola and Natal. It is possible, furthermore, that the latter may prove to be separable into an eastern and a western race.

We are sorry to differ from Mr. Hartert in this matter, and thus to continue the already more than unfortunate shifting of names which has fallen to the lot of this much buffeted species, but the facts as we see them allow no other course. It should be mentioned, moreover, that Doctor Reichenow, who undoubtedly had access to the type of *cyanostictus*, has arrived at precisely the same result as above set forth, and gives at some length the reasons for his position.^a He, however, treats *meridionalis* and *cyanostictus* as distinct species.

MELITTOPHAGUS OREOBATES Sharpe.

Melittophagus oreobates SHARPE, Ibis, 1892, p. 320 (Mount Elgon, British East Africa).

A single adult male of this rare bee-eater was taken by Doctor Abbott at Maranu, at an altitude of 5,000 feet on Mount Kilimanjaro, April 23, 1888. As will be noticed this specimen was obtained almost two years before the type was collected by Mr. Jackson, so that although the fact has so long remained unannounced Doctor Abbott was in reality the discoverer of the species.

MEROPS APIASTER Linnæus.

Merops apiaster LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 117 (Southern Europe).

Six specimens, from the following localities: Mount Kilimanjaro, 5,000 feet, October 16, 17, 1889; Taveta, December 4, 1888; Lumi River, near Mount Kilimanjaro, October 9, 1888; Aruscha-wa-chini, southwest of Kilimanjaro, October 22, 1888. All are in the well-known immature plumage, but have a narrow dusky bar, though not always conspicuous, below the yellow throat. "Iris red." One, taken December 4, is in process of molt.

MEROPS PERSICUS Pallas.

Merops persica PALLAS, Reis. Russ. Reichs, II, 1773, p. 708 (Caspian Sea).

Three specimens: two from the plains east of Mount Kilimanjaro, December 11, 1888, and January 5, 1889; with one from Taveta, November 8, 1888. "Iris red." These are very much more greenish than specimens in ordinary plumage, differing further as detailed for similar examples by Doctor Reichenow,^b and seem, as he suggests,^b to represent the winter dress of the species.

^a Ornith. Monatsber., 1900, pp. 86-87.

^b Vogel Africas, II, 1902, p. 323.

MEROPS NUBICUS Gmelin.

Merops nubicus Gmelin, Syst. Nat., I, i, 1788, p. 464 (Nubia).

One adult male, from Mombasa, taken January 20, 1890. "Irides red."

Family **BUCEROTIDÆ**.**LOPHOCEROS MELANOLEUCOS SUAHELICUS** Neumann.

Lophoceros melanoleucos suahelicus NEUMANN, Journ. f. Ornith., 1905, p. 187, (Morogoro, German East Africa).

Two specimens, from Taveta, taken, respectively, June 22 and August 16, 1888.

LOPHOCEROS DECKENI (Cabanis).

Buceros (Rhynchaceros) deckeni CABANIS, von der Decken's Reisen, III, 1869, p. 37, pl. vi (East Africa).

One specimen, from the plains of Taveta, June 28, 1888.

BYCANISTES CRISTATUS (Rüppell).

Buceros cristatus RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 3, pl. I, (Goraza, Zana Lake, Dembea, Abyssinia).

Five specimens, from Mount Kilimanjaro, Taveta, and Kahé.

Family **IRRISORIDÆ**.**IRRISOR ERYTHRORYNCHOS ERYTHRORYNCHOS** (Latham).

Upupa erythrorynchos LATHAM, Ind. Orn., I, 1790, p. 280 (Africa and Asia).

One immature male, from Taveta, taken February 8, 1889.

Doctor Reichenow is apparently right in reducing *Irrisor viridis* to a subspecies and restricting its range to extreme southern Africa,^a for the color of the tail is not a satisfactory character, although the birds from the Cape region are, as he claims,^a distinguishable by reason of a shorter tail and less extensive white wing markings.

RHINOPOMASTUS CABANISI (De Filippi).

Irrisor cabanisi DE FILIPPI, Rev. et Mag. de Zool., 1853, p. 289 (Upper White Nile, British Equatorial Africa).

One adult male, from the plains east of Mount Kilimanjaro, taken October 1, 1888. "Bill orange."

RHINOPOMASTUS CYANOMELAS SCHALOWI (Neumann).

Rhinopomastus schalowi NEUMANN, Journ. f. Ornith., 1900, p. 221 (Usandawe, German East Africa).

One adult male, from Taveta, August 14, 1888.

^a Vögel Africas, II, 1903, p. 340.

Family UPUPIDÆ.

UPUPA AFRICANA Bechstein.

Upupa africana BECHSTEIN, Latham's Allgem. Uebers. Vögel, IV, 1811, p. 172 (type locality, Cape of Good Hope, South Africa).

A single specimen, from the Useri River, near Mount Kilimanjaro, January 22, 1889. It is marked female, is decidedly paler than the male, has the abdomen streaked, and the lower tail-coverts white, but lacks the black band across the middle of the white basal part of the secondaries, such as it ought to have, and as other females in the United States National Museum collection show.

Family ASIONIDÆ.

ASIO MACULOSUS AMERIMNUS, new subspecies.

Chars. subsp.—Resembling *Asio*^a *maculosus maculosus*, but much paler throughout, as well as generally more ochraceous; legs, feet, face, and crissum less heavily barred with dusky.

Geographical distribution.—Eastern Africa, from Natal to German East Africa.

Description.—Type, adult female, Cat. No. 86457, U.S.N.M.; Durban, Natal; Thomas Ayres. Upper parts bistre brown, much mottled with buff, light ochraceous, and whitish, the last most conspicuous in large roundish spots on the hind-neck and external webs of the scapulars; tail bistre with broad broken bars of buff; wings of the same color, the coverts mottled with buff and buffy white, some of the greater series with broad, ill-defined broken bars of buffy, and large terminal or subterminal spots of white on the exterior webs, the quills with wide, irregular, and more or less imperfect bars of buff; face dull brownish gray, with obsolete barrings of darker; chin and throat white, separated by a bar of brown and ochraceous feathers; remainder of lower surface dull white, tinged with buff, particularly on breast and sides, and everywhere marked thickly with narrow cross lines of bistre, these least numerous on the lower tail-coverts; the breast, abdomen, and sides with scattered splotches of the same color; feet and thighs dull white with a tinge of buff, the latter considerably, the former scarcely, barred narrowly with bistre; lining of wing white, mottled and narrowly barred with bistre. Length of wing, 330;^b tail, 200; exposed culmen, 36; culmen without cere, 23; tarsus, 68 mm.

This hitherto unrecognized race appears to be of the same size as true *Asio maculosus*. Its differences from the latter are, however, not such as appear to be attributable to individual variation, since the

^aFor change of the generic name from *Bubo* to *Asio* see Stone, Auk, 1903, pp. 272-276.

^bImperfect.

Natal specimens are all in the gray phase. It may be distinguished from *Asio maculosus cinerascens*,^a whose range it approaches to the northward, in greater size, heavily feathered toes, and larger, more conspicuous whitish spots on cervix and scapulars. It seems to be quite certainly without a name, for the original *Asio maculosus*,^b as well as its only synonym,^c were both based on specimens from the Cape of Good Hope.

The single example of *Asio maculosus amerinnus* secured by Doctor Abbott was taken on Mount Kilimanjaro, at an altitude of 5,000 feet, November 8, 1889. It is a young female, chiefly in the downy plumage, though with wings and tail nearly full grown. The face is tawny ochraceous, scarcely barred, thus quite similar in this respect to the specimen from Rehoboth, Damara Land, mentioned by Doctor Reichenow;^d the general tone of the plumage is much more ochraceous than that of our specimens from Natal, and this, in connection with what Doctor Reichenow says of a bird from Songea, near Lake Nyassa,^e is added evidence of what has been intimated by a recent writer,^f that there exists in this species a kind of dichromatism, like that in the American forms of the genus.^g It is noteworthy that even in such a young bird the iris as reported by the collector is "straw yellow."

ASIO LACTEUS (Temminck).

Strix lactea TEMMINCK, Pl. Col., II, 1820, pl. iv (Senegal).

Bubo lacteus AUTHORS.

One apparently typical specimen, from the plains east of Mount Kilimanjaro, October 7, 1888. "Iris brown."

Family CAPRIMULGIDÆ.

CAPRIMULGUS FOSSII FOSSII Hartlaub.

Caprimulgus fossii HARTLAUB, Orn. Westafr., 1857, p. 23 (Verreaux, manuscript) (Gabun, western Africa).

Five specimens: one without data; the others from Kahé, south of Mount Kilimanjaro, May 8, 1888, September 5, 1888, and August 4, 1889. They appear to be typical *fossii*, though rather small. Aside from the sexual distinctions pointed out by Doctors Sharpe^g and Reichenow,^h our single adult female differs from the male in being more closely and evenly barred with dark brown or blackish on the

^a *Bubo cinerascens* Guérin, Rev. Zool., 1843, p. 321 (Abyssinia).

^b *Strix maculosa* Vieillot, Nouv. Dict. d'Hist. Nat., VII, 1817, p. 44.

^c *Strix africana* Temminck, Pl. Col., II, 1821, pl. I.

^d Vogel Africas, I, 1901, p. 655.

^e Sharpe, Ibis, 1904, p. 24.

^f Oberholser, Proc. U. S. Nat. Mus., XXVII, 1904, pp. 177 et seq.

^g Cat. Birds Brit. Mus., XVI, 1892, p. 551.

^h Vogel Africas, II, 1903, p. 365.

lower surface, this being particularly noticeable on the thighs, flanks, crissum, and lower abdomen.

Two immature birds—male and female—are paler and more grayish both above and below than the adults; both resemble the adult *male* in the barring of the posterior lower parts; otherwise the immature female is like the adult of that sex; while the immature male differs from the young female in having whitish instead of ochraceous tips to the innermost secondaries, nearly pure white in place of partly tawny spots on the primaries, and paler buff external webs of the outermost tail-feathers.

CAPRIMULGUS DONALDSONI Sharpe.

Caprimulgus donaldsoni SHARPE, Bull. Brit. Orn. Club, IV, No. XXV, 1895, p. xxix (Hargeisa, Somali Land).

A single specimen of this pretty as well as uncommon goatsucker was secured by Doctor Abbott. It is a female, not quite adult, from Taveta, August 18, 1888. This is quite an extension of its range, for the southernmost previous record of its occurrence appears to be Lake Baringo, British East Africa.^a It will be noted, also, that this is another of the many species of which Doctor Abbott was the real discoverer, but which, through unfortunate delay in publication, have fallen to the credit of others.

In view of the rarity of the species and the meagerness of most published accounts, the following description of Doctor Abbott's specimen may be of interest:

Forehead and crown chestnut, the feathers with irregularly shaped black shaft marks; nape like the crown, with but slight traces of black, these in the form of small, subterminal, triangular or tear-shaped spots, the feathers tipped with yellowish buff; back, rump, and upper tail-coverts paler—between hazel brown and chestnut—most of the feathers with narrow, brownish black shaft lines, broadest on the back; feathers of the rump, and to a less degree those of the upper tail-coverts, with very narrow, subterminal bars of blackish, immediately succeeded by broader, buffy white tips; scapulars chestnut, most of them with irregular black markings, terminating in bold, somewhat triangular, spots, and bordered distally, mostly on the outer webs, with buff; primaries brownish black, the three outer ones very sparsely mottled at the tip with chestnut; inner ones heavily mottled with pale chestnut; first primary with a small, roundish, pure white spot on the inner web, not reaching the shaft; second with a larger, less rounded white spot; third with a white bar on the inner web, touching the shaft, and a more narrow buffy white spot on the outer web; fourth with a pale cinnamon rufous bar on both webs; secondaries brownish black, with heavy, broken bars of

^aSharpe, Ibis, 1902, p. 111.

pale chestnut, the innermost feathers almost entirely of this color; wing-coverts chestnut, deeper on the bend of the wing, and mottled with blackish; middle and greater coverts broadly tipped with buffy white, most of the feathers with subterminal blackish bars; primary-coverts blackish, with broad hazel bars, the feathers mainly blackish at tips; under wing-coverts, bend of wing, and axillaries buff, with blackish and rufous bars on outer border of the under wing-coverts; first three primaries without hazel edging on inner webs, the remainder of the series conspicuously edged with this color; tail light hazel, much paler on the two middle feathers, which are finely, irregularly, and indistinctly freckled with dusky, the outer feathers more heavily marked and barred with blackish, the two outermost rectrices with a white tip that, on the inner web of the last feather, is 13.8 mm. long; lores, sides of head including ear-coverts, sides of neck and breast chestnut, some of the feathers on sides of neck tipped with buffy like nape, those of the middle of breast terminated with buffy white, most of them having also narrow, black shaft marks; chin and upper throat cinnamon rufous; lower throat with two white spots, separated by a narrow line of black-tipped rufous feathers, the lower border of these white spots also with black-tipped feathers; cheeks mixed cinnamon rufous and buffy white; abdomen and under tail-coverts buff, the former more or less obsoletely barred with brownish and rufous; feet and tarsi light brown in the dried skin. Length of wing, 130; tail, 92; tarsus, 19; culmen, 10.5 mm.

In the above description no mention is made of certain feathers of the plumage that are apparently those of the immature stage, from which the bird has recently emerged. These consist of a number of buffy gray feathers with fine darker vermiculations, that are scattered over the forehead and sides of the crown; and several similar feathers with blackish shaft lines, changing terminally to chestnut, that are to be found among the inner scapulars. The buffy under tail-coverts are probably also of the immature dress, as the feathers are of the characteristic, fluffy kind common to young birds.

In order that there should be as little chance as possible for an error in identification, Doctor Richmond compared the Abbott specimen with that collected by Mr. D. G. Elliot at The Haud in Somali Land, and has furnished the following result:

Our bird is so very similar that there can be no possible doubt regarding its identity. The Somali Land specimen has more vermiculated gray feathers on the head, back, and wings, while the rump and middle tail-feathers are largely of this color, and the other rectrices have more black; the white spot in the wing occupies the first four primaries instead of three as in our bird; also the white tip of the tail is more extensive than in ours.

In measurements the wings are almost exactly alike; the tail in our bird is 92 mm., in the other 97 mm.; the tarsus in both is the same, but the middle toe is nearly 2.5 mm. longer in our bird.

Family MICROPODIDÆ.

TACHYNAUTES,^a new genus.

Cypsiurus LESSON, Echo du Monde Savant, ann. 10, ser. 2, VIII, 1843, p. 134 (type, *Cypselus ambrosiacus* Temminck=*Cypselus parvus* Lichtenstein) (not *Cypsilurus* Swainson, 1839 [Pisces]).

Chars. gen.—Similar to *Tachornis* Gosse, but tail very long—about three-fourths the length of the wing, and forked for nearly two-thirds its length, the outer feathers distally very narrow and much attenuated.

Type.—*Cypselus parvus* Lichtenstein.

The type and sole species of this genus is quite remarkable for the development of the tail which is actually, and excepting *Claudia squamata*, relatively longer than in any other member of the subfamily Micropodinae, also with the single exception of *Panyptila sanctihieronymi* more deeply forficata. All the other species of the genus *Tachornis* Gosse,^b with which *parvus* has commonly been associated, have the tail barely more than half as long as the wing, or less, and forked for less than half its own length.

Although *Tachynautes parvus* has apparently not before been formally separated from its associates in the genus *Tachornis*, it formed the type of Lesson's *Cypsiurus*, a name now unavailable by reason of *Cypsilurus*, employed by Swainson^c for a genus of fishes.

TACHYNAUTES PARVUS PARVUS (Lichtenstein).

Cypselus parvus LICHTENSTEIN, Verz. Doubl. Zool. Mus. Berlin, 1823, p. 58 (Nubia, Africa).

Two specimens: one from Kahé, south of Mount Kilimanjaro, September 7, 1888; the other from the Lumi River, near Taveta, December 1, 1888. So far as it is possible to determine without examples of typical *Tachynautes parvus* for comparison, Doctor Abbott's birds seem to belong to this form. Their wing measurement is 127 and 125 mm., respectively, thus below the minimum given by Reichenow^d for even *parvus*; and in color also they answer better to the description of *parvus* than to that of *myochrous*, the form to be expected in this locality, though they are evidently to some degree intermediate in this respect. Assuming this identification to be correct, the range of *parvus* is thereby extended considerably to the southward.

Although Hartert in his recent review of this group recognizes but two forms of *parvus*,^e there seem to be at least four that are worthy of designation by name,^f as follows:

^a ταχύς, rapidus; ναύτης, nauta.

^b Birds Jamaica, 1847, p. 58, pl. ix (type, *Tachornis phenicobia* Gosse).

^c Nat. Hist. Fishes, Amphib., and Rept., I, 1838, p. 299.

^d Vogel Africas, II, 1903, p. 384.

^e Tierreich, I, 1897, p. 81.

^f See Reichenow, Vogel Africas, II, 1903, pp. 383–386.

Tachyantes parvus parvus (Lichtenstein).—Northeastern and northwestern Africa, from Nubia to Senegal and the Kilimanjaro region.

Tachyantes parvus myochrous (Reichenow).—Eastern Africa, from German East Africa to the Zambesi River.

Tachyantes parvus brachypterus (Reichenow)^a.—Western Africa, from Gambia to Damara Land.

Tachyantes parvus gracilis (Sharpe).—Madagascar.

MICROPUS MELBA AFRICANUS (Temminck).

Cypselus alpinus africanus TEMMINCK, Man. d'Orn., 1815, p. 270 (southern Africa).

Two specimens from Mount Kilimanjaro, taken at 5,000 and 10,000 feet, respectively. These are darker on the upper parts than examples from Europe and Asia in the United States National Museum, but that this is, as it seems to be, an additional character separating *Micropus m. africanus* from true *melba*, our series is unfortunately not extensive enough to determine.

If the generic term *Apus* Scopoli,^b applied to the swifts of this group, be refused as identical with the prior *Apos* Scopoli,^c the name to be used is not *Cypselus* Illiger,^d but *Micropus* Wolf,^e which latter Doctor Sharpe rejects^f apparently because of a supposed earlier *Micropus* Linnæus. So far as we are aware no such generic term was ever used by Linnæus.

MICROPUS HORUS (Heuglin).

Cypselus affinis var. *horus* HEUGLIN, Ornith. Nordost-Afr., I, 1869, p. 147 (Hartlaub, manuscript) (South Africa).^g

One adult female from Kahé, south of Mount Kilimanjaro, taken May 3, 1888.

MICROPUS MYOPTILUS (Salvadori).

Cypselus myoptilus SALVADORI, Ann. Mus. Civ. Genova, XXVI, 1888, p. 228 (Let Marefia, Shoa, Abyssinia).

A single adult male of this rare species was obtained by Doctor Abbott at an altitude of 5,000 feet, on Mount Kilimanjaro, January 2, 1890. This apparently is the second known specimen, as well as the first adult bird, the original description having been based on the immature plumage, and, furthermore, greatly extends the known range of the species. It may be described as follows:

Upper parts dark grayish brown, rather deeper on the interscapulum.

^a *Tachornis parvus brachypterus* REICHENOW, Vögel Africas, II, 1893, p. 386 (Gambia to Damara Land, western Africa).

^b Introd. Hist. Nat., 1777, p. 483 (type, *Hirundo apus* Linnæus).

^c Idem, 1777, p. 404 (Crustacea).

^d Prod. Syst. Mam. et Avium, 1811, p. 229.

^e Meyer and Wolf, Taschenb. deutsch. Vögelk., I, 1810, p. 280.

^f Hand-List Gen. and Spec. Birds, II, 1900, p. 95.

^g This is not a *nomen nudum* as stated by Reichenow (Vögel Africas, II, 1903, p. 381).

and noticeably paler on the forehead, particularly the lateral portions, the pileum, rump, and upper tail-coverts with slightly paler margins, producing an obsoletely squamate effect; tail of the same color as the back, and deeply forked, the outer feathers conspicuously narrowed terminally, as in *Micropus caffer*, but more extensively; wings like the upper surface, but the outer webs of the quills darker, the inner ones lighter than the back; a blackish spot in front of the eye; sides of head and neck rather paler than the pileum; chin and upper throat pale grayish brown, merging insensibly into the darker color of the surrounding parts; rest of ventral surface grayish brown, somewhat lighter than that of the upper parts; the feathers of lower abdomen and inferior tail-coverts with obsoletely paler tips; under wing-coverts grayish brown like the lower parts, but lighter along the edge of the wing. Length of wing, 127; outermost tail-feathers, 79; middle tail-feathers, 41; exposed culmen, 5.5; tarsus, 8.5; middle toe, 7.5 mm.

Family COLIIDÆ.

COLIUS LEUCOTIS AFFINIS Shelley.

Colius leucotis affinis SHELLEY, Ibis, 1885, p. 312 (Dar-es-Salaam, German East Africa^a).

Five specimens: from Taveta; Mount Kilimanjaro, 5,000 feet; Maranu, Kilimanjaro; and Kahé, south of Kilimanjaro. "Iris red; feet dark pink, sometimes red." These are apparently typical *affinis*; they vary much in color individually, as do others mentioned by Doctor Reichenow.^b

UROCOLIUS MACROURUS MACROURUS (Linnæus).

Lanius macrourus LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 134 (Senegal, western Africa).

Colius macrourus pulcher NEUMANN, Journ. f. Ornith., 1900, p. 190 (Teita, British East Africa).

One adult male, from the plains east of Mount Kilimanjaro, September 21, 1888. So far as we can discover it does not differ, except in slightly larger size, from an example taken in Somali Land.

Mr. Oscar Neumann has recently separated the German and British East Africa bird from that of Abyssinia, under the name *Colius macrourus pulcher*,^c at the same time suggesting that the bird from Senegal might be different, and if so, should be called *Colius macrourus senegalensis* (Gmelin). The Senegal bird, not that from Abyssinia as supposed by Mr. Neumann, is, however, the true *macrourus*, for Linnaeus' description^d was founded on the "Coliou

^a Captain Shelley, in letter.

^b Vögel Africas, II, 1903, p. 205.

^c Journ. f. Ornith., 1900, p. 190.

^d Syst. Nat., 12th ed., I, 1766, p. 134.

hupé du Sénégal" of Brisson;^a of which Gmelin's *Colinus senegalensis*,^b based primarily on the same description and figure, is of course a pure synonym. Neumann gives no characters to distinguish from typical *macrourus* of western Africa the form which he calls *pulcher*, as a consequence of which the status of this race must for the present be held in abeyance. The subspecies from Abyssinia is thus left without a name, and should it prove sufficiently different, as Neumann asserts, by reason of its paler head, yellowish forehead, and lack of bluish wash on the crown, it may be known as *Urocolius macrourus syntactus*.

There seems to be excellent reason for recognizing at least two genera of Coliidae, instead of the single one currently considered coextensive with the family. The two species, *macrourus* and *indicus* (= *erythromelon* Authors), including of course their various subspecies, are both very much in contrast to all the others by reason of their peculiar, narrow tail-feathers, comparatively long outermost primary, red basal portion of the maxilla, and other details of coloration. The type of *Colinus*^c is *C. colinus*, so that this name must be restricted to the broad-tailed species; while for the others the term *Urocolius*,^d type *C. macrourus*, is available.

The following forms of *Urocolius* seem to be recognizable:

- Urocolius macrourus macrourus* (LINNÆUS).
- Urocolius macrourus syntactus* OBERHOLSER.
- Urocolius indicus indicus* (LATHAM).
- Urocolius indicus mossambicus* (REICHENOW).
- Urocolius indicus lacteifrons* (SHARPE).
- Urocolius indicus pallidus* (REICHENOW).
- Urocolius indicus angolensis* (REICHENOW).

Family TROGONTIDÆ.

APALODERMA NARINA NARINA (Stephens).

Trogon narina STEPHENS, Shaw's Gen. Zool., IX, 1815, p. 14 (Caffraria; Auteniquoi country to the Gamtoo River [type locality, Kaffir Land]).

One adult male, taken at Taveta, July 6, 1888.

HETEROTROGON VITTATUS (Shelley).

Hapaloderma vittatum SHELLEY, Proc. Zool. Soc. Lond., 1882, p. 306 (Mamboio, German East Africa).

Four specimens of this rare trogon were collected by Doctor Abbott on Mount Kilimanjaro, at altitudes of 6,000 and 7,000 feet. Two of these are females and have been already fully described by Dr. Charles W. Richmond.^e

^a *Colius senegalensis cristatus* Brisson, Ornith., III, 1760, p. 306, pl. xvi, fig. 3.

^b Syst. Nat., I, ii, 1788, p. 842.

^c Brisson, Ornith., III, 1760, p. 304.

^d Bonaparte, Consp. Voluer. Anisod., 1854, p. 3.

^e Proc. U. S. Nat. Mus., XVII, 1895, pp. 602-603.

Family CAPITONIDÆ.

LYBIUS MELANOPTERUS (Peters).

Pogonias (Laimodon) melanopterus PETERS, Bericht Verhandl. Kgl. Akad. Wiss. Berlin, 1854, p. 134 (Mozambique).

One specimen, from eastern Africa.

LYBIUS ABBOTTI (Richmond).

Melanobucco abbotti RICHMOND, Auk, XIV, 1897, p. 164 (Plains of Taveta, British East Africa).

One specimen, an adult female, was obtained by Doctor Abbott on the plains of Taveta, July 22, 1888. This is the type of the species, to Doctor Richmond's original description of which there is little to add. Doctor Reichenow has synonymized *Lybius abbotti* with *Lybius albicaudus*^a, giving the intimation that he considers it simply an older individual of that species. If this be really the case, then *Lybius senex* is also undoubtedly the same, a possibility that Doctor Reichenow has already suggested, though he keeps the two birds separate.^b It is indeed somewhat strange that three species so closely allied should occupy so nearly the same general region; but the changes of plumage in this genus are so imperfectly known, the differences characterizing *albicaudus*, *abbotti*, and *senex*, so well marked, and so little appear to be due to age, that without actual intermediates it seems preferable, under the circumstances, to consider them distinct species until positive proof to the contrary be forthcoming. The three may be distinguished chiefly as follows:

Lybius albicaudus.—Breast and abdomen dark brown, the feathers with white tips.

Lybius abbotti.—Breast and upper abdomen pure white, only the sides, flanks, and lower abdomen dark brown mixed with white.

Lybius senex.—Entire lower surface pure white.

TRICHOLÆMA LACRYMOSUM Cabanis.

Tricholaema lacrymosa CABANIS, Journ. f. Ornith., 1878, p. 205 (Kitui, and Adi River, British East Africa).

One adult male from Taveta, August 15, 1888.

TRICHOLÆMA STIGMATOTHORAX Cabanis.

Tricholaema stigmatothorax CABANIS, Journ. f. Ornith., 1878, p. 205 (Ndi, Teita, British East Africa).

One adult female from the Useri River, near Mount Kilimanjaro, January 17, 1889.

^a Vögel Africas, II, 1903, pp. 122-123.

^b Idem, II, 1903, p. 123.

SMILORHIS KILIMENSIS Shelley.

Smilorhis kilimensis SHELLEY, Ibis, 1889, p. 477 (Kilimanjaro district, eastern Africa).

Three specimens: one from Taveta, August 14, 1888, the two others without date. One of these is evidently immature, and has the rump chiefly brownish black with an admixture of white; but the ridge-like crest on the base of the culmen is fairly well developed.

VIRIDIBUCCO,^a new genus.

Chars. gen.—Similar to *Xylobucco* (*Barbatula* of authors), but bill smaller, weaker, less turgid, the culmen perfectly straight instead of decidedly curved, and rounded, with scarcely a perceptible ridge; no naked space surrounding the eye; secondaries not so long, falling short of the primary tips by almost the length of the exposed culmen.

Type.—*Barbatula leucomystax* Sharpe.

The type of this new genus has been usually included among the forms of *Xylobucco*, but, as will be readily seen by the above diagnosis, it is quite out of place in such company. Captain Shelley referred it to *Stactolæma* Marshall,^b but it differs radically from the members of that group, as follows: Bill smaller, weaker, much less turgid, the culmen straight; rictal and frontal bristles numerous and well developed; secondaries shorter; length of first toe less than half the fourth. Apparently the only other congeneric species is *Barbatula simplex* Fischer and Reichenow.^c This group will therefore comprise *Viridibucco leucomystax* (Sharpe) and *Viridibucco simplex* (Fischer and Reichenow).

Several changes appear to be necessary in Doctor Reichenow's recent arrangement^d of the species belonging to the current genera *Barbatula*, *Smilorhis*, and *Stactolæma*. Dr. C. W. Richmond has called my attention to the fact that the name *Barbatula* Lesson^e is preoccupied in ichthyology by *Barbatula* Linck;^f and it must therefore be rejected in favor of *Xylobucco* Bonaparte,^g since *Xylobucco scolopaceus* Bonaparte, the type of the last, is strictly congeneric with *Bucco erythronotus* Cuvier, the type of *Barbatula* Lesson. Doctor Reichenow's *Lignobucco*,^h based on *X. scolopaceus*, is of course synonymous. The same author has attemptedⁱ to separate *Barbatula duchaillui* Cassin

^a *Viridis* + *bucco*.

^b Birds of Africa, I, 1896, p. 129.

^c Journ. f. Ornith., 1884, p. 180 (Pangani, German East Africa).

^d Vögel Africas, II, 1903, pp. 139–153.

^e Compl. Buffon, IX, 1837, p. 292.

^f Mag. Neuste Phys. u. Nat., VI (3), 1790, p. 38.

^g Conspectus Avium, I, 1850, p. 141.

^h Journ. f. Ornith., 1887, p. 299.

ⁱ Vögel Africas, II, 1903, pp. 142–143.

from its associates in the genus *Xylobucco* (= *Barbatula*), and to unite it generically with the species of the genera *Stactolæma* and *Smilorhis* under the name *Buccanodon* Hartlaub.^a He bases this separation of *B. duchaillui* from *Xylobucco* apparently on the supposition that this species has the proportion of the toes different from that obtaining among the species of *Xylobucco*, and like that found in *Smilorhis* and *Stactolæma*, i. e., the first toe about equal to the half of the fourth; but in all the *fully adult* and otherwise perfect specimens of *duchailui* examined by us the length of the first toe is decidedly less than half the fourth, and thus exactly as in *Xylobucco*, though curiously enough in one or two examples that are apparently immature the proportions of the first and fourth toes are as in *Smilorhis* and *Stactolæma*. As there are absolutely no other characters to separate *duchailui* from *Xylobucco*, it must be replaced in that group, and the two generic names founded upon it, *Buccanodon* Hartlaub^a and *Cladurus* Reichenow,^b be entered as synonyms under *Xylobucco*. Both *Smilorhis* and *Stactolæma* are perfectly good genera, as Doctor Sharpe has always consistently claimed, and there seems to be no good reason for uniting them as Doctor Reichenow has done. Their characters, as well as those of the two other genera here involved, will appear in the following diagnoses:

1. *Stactolæma*.

Stactolæma MARSHALL, Proc. Zool. Soc. Lond., 1870, p. 118 (type, *Buccanodon anchietæ* Bocage).

Bill large and swollen, the culmen curved, with no conspicuous ridge; riatal and frontal bristles few or none, and, if present, very weak; no naked space surrounding the eye; secondaries falling short of the primaries by not more than two-thirds of exposed culmen; first toe about equal to half the fourth.

The species of this genus are:

Stactolæma anchietæ (Bocage).

Stactolæma olivaceum (Shelley).

Stactolæma woodwardi Shelley.

2. *Smilorhis*.

Smilorhis SUNDEVALL, Meth. Av. Tent. 1873, p. 75 (type, *Megalæma leucotis* Sundevall).

Bill large and turgid, the culmen curved throughout, with a conspicuous crest on its basal portion; riatal and frontal bristles fairly well developed; an unfeathered space around the eye; secondaries short, the difference between their tips and those of the primaries more than the length of exposed culmen; first toe about equal to the fourth.

^a Orn. Westair., 1857, p. 171.

^b Journ. f. Ornith., 1877, p. 17.

The following species appear to be referable here:

Smilorhis whytii Shelley.
Smilorhis sowerbyi (Sharpe).
Smilorhis bocagei (Sousa).
Smilorhis leucotis (Sundevall).
Smilorhis kilimensis Shelley.

3. Viridibucco.

Viridibucco OBERHOLSER, p. 865 (type, *Barbatula leucomystax* Sharpe).

Bill small, weak, not swollen, the culmen straight, rounded, with scarcely a perceptible ridge; rictal and frontal bristles well developed; no bare space around the eye; secondaries falling short of the primaries by almost the length of the exposed culmen; first toe less than half the length of the fourth.

Two species are to be included:

Viridibucco leucomystax (Sharpe).
Viridibucco simplex (Fischer and Reichenow).

4. Xylobucco.

Barbatula LESSON, Compl. Buffon, IX, 1837, p. 292 (not Gmelin) (type, *Bucco erythronotus* Cuvier).

Xylobucco BONAPARTE, Consp. Avium, I, 1850, p. 141 (type, *Xylobucco scolopaceus* Bonaparte).

Buccanodon HARTLAUB, Orn. Westafr., 1857, p. 171 (type, *Barbatula duchaillui* Cassin).

Cladurus REICHENOW, Journ. f. Ornith., 1877, p. 17 (type, *Barbatula duchaillui* Cassin).

Lignobucco REICHENOW, Journ. f. Ornith., 1887, p. 299 (type, *Xylobucco scolopaceus* Bonaparte).

Bill comparatively large and turgid, the culmen curved, with a well-defined ridge on its basal portion; rictal and frontal bristles well developed; a naked space surrounding the eye; secondaries falling short of primaries by less than half of exposed culmen; first toe less than half of fourth.

This genus comprises the following species:

Xylobucco scolopaceus scolopaceus Bonaparte.
Xylobucco scolopaceus stellatus (Jardine and Fraser).
Xylobucco scolopaceus flavisquamatus (Verreaux).
Xylobucco scolopaceus consobrinus (Reichenow).
Xylobucco erythronotus (Cuvier).
Xylobucco leucolaimus (Verreaux).
Xylobucco bilineatus (Sundevall).
Xylobucco fischeri (Reichenow).
Xylobucco kandti (Reichenow).
Xylobucco jacksoni (Sharpe).
Xylobucco chrysopygus (Shelley).
Xylobucco subsulphureus (Fraser).
Xylobucco chrysocomus chrysocomus (Temminck).
Xylobucco chrysocomus guineensis (Reichenow).
Xylobucco chrysocomus xanthostictus (Blundell and Lovat).
Xylobucco chrysocomus schoanus (Neumann).
Xylobucco chrysocomus centralis (Reichenow).
Xylobucco chrysocomus extoni (Layard).
Xylobucco duchaillui duchaillui (Cassin).
Xylobucco duchaillui ugandae (Reichenow).
Xylobucco pusillus (Dumont).
Xylobucco minutus (Bonaparte).
Xylobucco affinis (Reichenow).
Xylobucco uropygialis (Heuglin).
Xylobucco coryphæus (Reichenow).

A key to the four genera above treated would read somewhat as follows:

- a. Bill weak; culmen straight *Viridibucco*
- a.' Bill stout; culmen curved.
- b. No naked space around eye; bristles of bill few or absent *Stactolema*
- b.' A naked space around eye; bristles of bill well developed.
- c. First toe about equal to half of fourth; secondaries falling short of primaries by more than exposed culmen *Smilorhis*
- c.' First toe decidedly less than half of fourth; secondaries falling short of primaries by less than half of exposed culmen *Xylobucco*

VIRIDIBUCCO LEUCOMYSTAX (Sharpe).

Barbatula leucomystax SHARPE, Ibis, 1892, p. 310 (Sotik, British East Africa).

Two specimens: an adult male, from Mount Kilimanjaro, at 5,000 feet, September 1, 1889; and an adult female, from Mount Kilimanjaro, at 6,000 feet, November 10, 1888. The male is a little brighter in color above than the female, but in other respects appears to be identical.

Family INDICATORIDÆ.

INDICATOR INDICATOR (Sparrman).

Cuculus indicator SPARRMAN, Philos. Trans., 1777, p. 43 ("Groot Vaders Bosch," near Swellendam, vicinity of Cape of Good Hope, South Africa).

Cuculus indicator GMELIN, Syst. Nat., I, i, 1788, p. 418 (interior of Africa).

Two specimens: an adult male, from the plains east of Mount Kilimanjaro, October 5, 1888; and an immature male, from the Useri River, Mount Kilimanjaro, December 13, 1888. The latter is in the plumage which so closely and puzzlingly resembles *Indicator maior*, the short median upper tail-coverts being pure white, the jugulum and throat tinged with yellow, the chin faintly washed with the same, the flanks without brown streaks, the feathers of the forehead and crown margined with yellowish brown; but the chin and upper throat are mottled with brownish black and the bill is pale brownish, both of which are distinguishing marks.

MELIGNOTHES MINOR DIADEMATUS (Rüppell).

Indicator diadematus RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 61 (wooded region of Abyssinia).

Indicator minor teitensis NEUMANN, Journ. f. Ornith., 1900, p. 195 (Bura, Teita, British East Africa).

A single female was obtained by Doctor Abbott at Taveta, July 7, 1888. "Skin extremely tough." Its measurements are: Wing, 82; tail, 51; exposed culmen, 9.5; tarsus, 14; middle toe, 12 mm.

That two species of small honey-guides inhabit most of Abyssinia was suspected by Rüppell, who distinguished them and named the paler one *diadematus*;^a by mistake, however, considering the darker

^a Neue Wirb. Faun. Abyss., Vögel., 1835, p. 61.

bird true *minor*. The latter (*minor* of Rüppell) is in reality identical with *pachyrhynchus* of Heuglin,^a which is specifically distinct from *minor*, as hereinafter shown. The bird named *diadematus* by Rüppell, though closely related to *minor*, appears to be subspecifically separable. Neumann, missing the point that there are two distinct species found together in northeastern Africa, also failing to discover Rüppell's error in identification of *minor*, thereby identified *diadematus* Rüppell with *pachyrhynchus* Heuglin. Then, as a natural consequence, he thought the northern form of *minor* (*diadematus*) undescribed, and renamed it *teitensis*.^b The latter name must therefore give way to *diadematus*, unless future investigation prove the bird from the Kilimanjaro region different from both the South African *minor* and the Abyssinian *diadematus*.

MELIGNOTHES EXILIS MELIPHILUS, new subspecies.

Chars. subsp.—Similar to *Melignothes exilis exilis*,^c but decidedly larger; white area on tail less extensive; crown and cervix much more tinged with yellowish olive green; upper parts less streaked with dark brown—almost uniform.

Description.—Type, adult male, Cat. No. 117965, U.S.N.M.; Taveta, British East Africa, August 15, 1888; Dr. W. L. Abbott. Pileum and nape dull grayish olive green, the extreme forehead blackish, with a very small white spot behind the nostrils, the feathers of the fore part of the crown with blackish shafts; back, scapulars, rump, and upper tail-coverts golden olive green, the centers of the feathers narrowly and obscurely brownish, this barely noticeable when the plumage is undisturbed; four middle tail-feathers blackish brown, edged with olive green; remaining rectrices white, with restricted tips of dark brown, and similarly colored basal areas that on the two outer pairs of feathers are barely visible, but on the others occupy diagonally nearly two-thirds of the length; wings fuscous, the quills edged externally with golden olive green, the greater and median coverts more broadly margined with the same, the lesser coverts almost uniform olive; sides of head and neck brownish gray with a wash of greenish; chin whitish, broadly streaked with dark brownish gray; throat plain brownish ashy; breast, sides, and flanks dull buffy gray with a greenish tinge, the flanks paler and broadly streaked with dark brown; abdomen and crissum brownish white; under wing-coverts brownish gray, the axillars paler, the edge of wing whitish olive yellow; bill brownish black, the base of mandible decidedly paler. Length of wing, 73; tail, 47.5; exposed culmen, 7.5; tarsus, 12.5; middle toe, 11 mm.

^a *Melignothes pachyrhynchus* Heuglin, Journ. f. Ornith., 1864, p. 266.

^b Journ. f. Ornith., 1900, p. 195.

^c Type compared.

Doctor Abbott secured only the single specimen above described, but this is an adult in fresh plumage, and demonstrates clearly its specific distinctness from *Melignothes minor diadematus* (Rüppell) (= *teitensis* Neumann) obtained at the same locality, proving thus the existence of two entirely distinct species in this part of Africa. From *diadematus* this new form differs as follows: Size smaller, particularly the wing and bill; upper parts darker, less yellowish, the head more greenish; chin and throat darker, the former conspicuously streaked; breast with more of a greenish wash, inferior wing-coverts brownish gray instead of dull white. From *Melignothes exilis pachyrhynchus* (Heuglin) it may be distinguished by its decidedly smaller size and the lack of blackish shaft streaks on the upper parts. Considerable hesitation preceded the determination to describe *meliphilus* as new, but a very careful investigation, involving all the known forms of the smaller honey-guides seems to permit no other logical course. As this study has revealed the apparent necessity of some readjustment of previously entertained views of the relationships of the species, the results may be here set forth as a slight contribution to our knowledge of these difficult birds.

The genus *Indicator*, as at present regarded, comprises two well-defined groups—one of generally larger species, with longer, more slender bills, typified by *Indicator indicator*; the other of smaller forms, with relatively short, stout beaks, represented by *I. conirostris*. The structural differences characterizing the latter, as below detailed, seem quite sufficient for its recognition as a separate genus, to which the name *Melignothes* Cassin,^a based on *I. conirostris*, therefore becomes applicable. Doctor Reichenow admits only five forms of this group,^b all of which he treats as distinct species; while Mr. Neumann,^c going to the other extreme, holds them all for subspecies of *minor*, with the addition of *diadematus*, and excepting *lorati* which was at that time not yet described. There seem to be, however, at least three specific types—*minor*, *exilis*, and *conirostris*—with possibly a fourth in *lorati*; and all the other admissible forms appear to be but geographical races of these. To judge from the characters—osteological and other—given by Stoliczka,^d the Indian *Pseudofringilla xanthonota* (Blyth) is generically very distinct from both *Indicator* and *Melignothes*. Other pertinent notes are set forth in the following review of the

Genus *Melignothes* Cassin.

Melignothes CASSIN, Proc. Acad. Nat. Sci. Phila., 1856, p. 156 (type, *Melignothes conirostris* Cassin).

Melignostes HEINE, Journ. f. Ornith., 1860, p. 102 (nom. emend. pro *Melignothes*) (type, *Melignothes conirostris* Cassin).

^aProc. Acad. Nat. Sci. Phila., 1856, p. 156.

^bVögel Africas, II, 1903, pp. 110-113.

^cJourn. f. Ornith., 1900, p. 195.

^dStray Feathers, I, 1873, p. 426.

Chars. gen.—Similar to *Indicator Vieillot*,^a but bill shorter, stouter, more conoid, its height at base not decidedly less than length of culmen from anterior edge of nasal fossa, nor less than length of gonys; gonydeal angle much more prominent, the gonys much more ascending; nares more rounded, provided with a more prominent tubular membrane, and set at a greater posteriorly divergent angle to the axis of the culmen, lying thus parallel to the lateral outlines of the bill instead of to the sides of its central ridge.

Geographical distribution.—All of Africa, except the northwestern portion.

ANALYTICAL KEY TO THE SPECIES AND SUBSPECIES OF MELIGNOTHES.

- A. Bill entirely black; under surface darker—slate gray.
 - a. Crown like the back *ussleri*
 - a'. Crown conspicuously different from back.
 - b. Head and neck more slaty; yellowish edgings of back and wings brighter *conirostris*
 - b'. Head and neck more brownish; yellowish edgings of back and wings duller *lorati*
- B. Bill with base of mandible pale; under surface lighter—dull pale brownish gray, or whitish.
 - a. Lighter; upper parts more yellowish; under wing-coverts white or nearly so; bill usually larger.
 - b. Larger—wing generally over 85 mm *minor*
 - b'. Smaller—wing generally under 85 mm *diadematus*
 - a'. Darker; upper parts less yellowish; under wing-coverts dull grayish or brownish; bill smaller.
 - b. Wing over 75 mm *pachyrrhynchus*
 - b'. Wing under 75 mm.
 - c. Back not conspicuously streaked with blackish or dark brown *meliphilus*
 - c'. Back conspicuously streaked with blackish or dark brown.
 - d. Pileum chiefly yellowish olive *willrocksii*
 - d'. Pileum chiefly gray or brown.
 - e. Crown uniform cinereous *poensis*
 - e'. Crown brownish gray, with darker shaft-streaks, and slightly washed with olive yellow *exilis*

1. *Melignothes conirostris conirostris* Cassin.

Melignothes conirostris CASSIN, Proc. Acad. Nat. Sci. Phila., 1856, p. 156 (Munda River, Gabun, western Africa).

Indicator occidentalis HARTLAUB, Orn. Westafr., 1857, p. 185, in text (Verreaux, manuscript) (Gabun, western Africa).

Geographical distribution.—Gabun to Kamerun, western Africa.

This large, dark-colored species is very distinct from both *M. exilis* and *M. minor*, occupying practically the same region as the former, and it can by no means be considered only a subspecies of the latter, as proposed by Mr. Neumann.^b The type is still in the collection of the Academy of Natural Sciences of Philadelphia, and still in a good state of preservation. Through the kindness of Mr. Witmer Stone it has been examined, and the following measurements taken: Wing, 83; tail, 53; exposed culmen, 9.5; tarsus, 16; middle toe, 13.5 mm.

^aAnalyse Ornith., 1816, p. 28 (type, *Cuculus indicator* Sparrman).

^bJourn. f. Ornith., 1900, p. 195.

2. *Melignotheres conirostris ussheri* (Sharpe).

Indicator ussheri SHARPE, Bull. Brit. Orn. Club, XII, 1902, p. 80 (Fantee, western Africa).

Geographical distribution.—Gold Coast, western Africa.

This recently described form is the northern representative of *conirostris*, and apparently only a subspecies. It differs chiefly in the more golden olive cast of the pileum and the rather paler lower parts. The wing length given by Doctor Sharpe^a—4.65 inches (117 mm.)—is evidently a mistake, possibly a slip for 3.65 inches, as this dimension as given would make *ussheri* larger in length of wing than any other honey-guide, with other measurements disproportionately small.

3. *Melignotheres lovati* (Grant).

Indicator lovati GRANT, Bull. Brit. Orn. Club, X, 1900, p. xxxix (Gelongol, southern Abyssinia).

Geographical distribution.—Southern Abyssinia.

Apparently most nearly related to *M. conirostris*, possibly only sub-specifically distinct, and distinguishable by its grayish brown head and cervix, together with the decidedly duller yellowish edgings of back and wing-coverts. Mr. Neumann is probably wrong in treating *lovati* as a subspecies of *minor*.^b

4. *Melignotheres minor minor* (Stephens).

Indicator minor STEPHENS, Shaw's Gen. Zool., IX, 1815, p. 140 (Cape of Good Hope).

Indicator minimus TEMMINCK, Pl. Col., III, 1822, pl. DXLII, fig. 1 (southern Africa).

Indicator buphagoides LEADBEATER, Trans. Linn. Soc. Lond., XVI, 1829, p. 91 (interior of Africa).

Indicator apivorus LICHTENSTEIN, Nomencl. Av., 1854, p. 78 (*nomen nudum*).

Geographical distribution.—Southern Africa, north to Damara Land and probably at least the Zambesi River.

The much paler, less variegated upper parts, light basal portion of the mandible, much paler, more brownish lower parts, and white or brownish white lower wing-coverts easily distinguish this species from *Melignotheres conirostris*. The northern limit of its distribution in eastern Africa, as well as the area of its inosculation with *M. minor diadematus*, remain to be determined. The name *Indicator buphagoides*^c apparently is, as commonly regarded, a synonym of *minor*, though it is based on a bird with a bill somewhat too small, if there be no mistake in the measurement as recorded in the original description.

5. *Melignotheres minor diadematus* (Rüppell).

Indicator diadematus RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 61 (wooded region of Abyssinia).

Indicator minor teitensis NAUMANN, Journ. f. Ornith., 1900, p. 195 (Bura, Teita, British East Africa).

Geographical distribution.—German East Africa north to Somali Land, Abyssinia, and Bongo in the southeastern Sudan.

^aBull. Brit. Orn. Club, XII, 1902, p. 80.

^bJourn. f. Ornith., 1904, p. 384.

^cLeadbeater, Trans. Linn. Soc. Lond., XVI, 1829, p. 91.

This northern form seems to differ from *minor* principally in its smaller size, a character, however, which is quite decided enough for purposes of subspecific separation. The application of the names *diadematus* and *teitensis* has been discussed above.^a

6. *Melignothres exilis exilis* Cassin.

Melignothres exilis CASSIN, Proc. Acad. Nat. Sci. Phila., 1856, p. 157 (Munda River, Gabun, western Africa).

Geographical distribution.—Loango to Kamerun, western Africa. This species, including its various forms, is, as held by Doctor Reichenow,^b specifically distinct from *minor*. It differs as a whole from the latter in its usually darker, less yellowish upper parts; darker anterior lower surface; smaller bill; and dull grayish or brownish, instead of white or whitish under wing-coverts. Races of the two species—*minor* and *exilis*—occur together in northeastern Africa as far south, at least, as the Kilimanjaro district, but elsewhere occupy separate geographical areas.

The type of *exilis* is a bird somewhat immature, and has for many years been exposed as a mounted specimen, therefore is rather duller than fresh adult examples. Its entire lower surface, excepting the paler crissum and median portion of the lower abdomen, is dull greenish gray. Its measurements are: Wing, 62.5; tail, 40; exposed culmen, 7; tarsus, 13; middle toe, 11.5 mm.

7. *Melignothres exilis willcocksii* (Alexander).

Indicator willcocksii ALEXANDER, Bull. Brit. Orn. Club, XII, 1901, p. 11 (Prahou, Gold Coast Colony, western Africa).

Geographical distribution.—Gold Coast, western Africa.

A northern form of *exilis* in which the crown is more conspicuously and chiefly yellowish olive instead of olive brown; there also seems to be a less distinct dusky band below the cheeks and auriculars. There is not the material difference in the size of the two forms claimed by Mr. Alexander,^c but *willcocksii* is apparently entitled to stand as a subspecies, although Doctor Reichenow has synonymized it with *exilis*.^d

8. *Melignothres exilis poensis* (Alexander).

Indicator poensis ALEXANDER, Bull. Brit. Orn. Club, XIII, 1903, p. 33 (Bakaki, Fernando Po).

Geographical distribution.—Fernando Po, western Africa.

An island race of *exilis*, which differs principally in its uniform cinereous crown. As may be seen by comparison of the original measurements of *poensis* with the above given dimensions of the type of *exilis*, the present form is not mentionably smaller.

9. *Melignothres exilis pachyrhynchus* (Heuglin).

Melignothres pachyrhynchus HEUGLIN, Journ. f. Ornith., 1864, p. 266 (Bongo, south-eastern Sudan, central Africa).

Indicator pugnax REICHENOW, Journ. f. Ornith., 1892, p. 24 (Bukoba, Victoria Nyanza, German East Africa).

^a See pp. 868–869.

^d Vögel Africas, II, 1903, p. 113.

^b Vögel Africas, II, 1903, p. 113.

^c Bull. Brit. Orn. Club, XIII, 1903, p. 33.

^e Bull. Brit. Orn. Club, XI, 1901, p. 11.

Geographical distribution.—Abyssinia and Bongo, south to Victoria Nyanza.

This form appears to be easily separable from *exilis*, though chiefly on account of its much larger size and rather more greenish pileum and cervix.

The name *Melignotheres pachyrhynchus* of Heuglin^a undoubtedly applies to a bird of the *exilis* type, as an examination of his descriptions and his accompanying comments clearly shows. Doctor Reichenow's *Indicator pygmaeus*,^b from the same general region, a little farther to the southward, appears to be quite certainly the same, as indicated by its almost identical dimensions and blackish-striped mantle. The bird from Sotik recorded as true *exilis* by Doctor Sharpe^c is probably also *pachyrhynchus*.

10. *Melignotheres exilis meliphilus* Oberholser.

Melignotheres exilis meliphilus OBERHOLSER, p. 869.

Geographical distribution.—Kilimanjaro region, eastern Africa.

Family PICIDÆ.

CAMPETHERA NUBICA (Boddaert).

Picus nubicus BODDAERT, Tabl. Plan. Enlum., 1783, p. 41 (Nubia).

Two adult females: one from Taveta, the other from the plains east of Mount Kilimanjaro. "Irides pink." Both are apparently typical, showing no approach to *pallida* or *neumannii*.

Misled by an incorrect quotation of Captain Shelley's,^d which inadvertently was not verified at the time, the present writer was unfortunately induced to enter a plea^e for the retention of the generic name *Dendromus* for the group to which the above species belongs. The proper name, however, is undoubtedly *Campethera* Gray, since *Dendromus* Swainson, 1837, is preoccupied by *Dendromus* Smith,^f which latter proves to be identical in orthography.

DENDROPICOS GUINEENSIS MASSAICUS Neumann.

Dendropicus guineensis massaicus NEUMANN, Journ. f. Ornith., 1900, p. 206 (Ndalaní, Nguruman Lake, Masai Land, German East Africa).

Two adult females from Taveta. These both are apparently typical of the small-sized form with red upper tail-coverts and distinctly barred back, which Neumann has named as above, and which seems to be an excellent race, although Doctor Reichenow is inclined to deny it recognition.^g

^a Journ. f. Ornith., 1864, p. 266; Ornith. Nordost-Afr., I, 1871, p. 773.

^b Idem, 1892, p. 24.

^c Ibis, 1892, p. 309.

^d Birds of Africa, I, 1896, p. 131, footnote.

^e Proc. U. S. Nat. Mus., XXII, 1899, p. 14.

^f Smith, Zool. Journ., IV, 1829, p. 439.

^g Vögel Africas, II, 1902, p. 194.

MESOPICOS SPODOCEPHALUS RHODEOGASTER (Fischer and Reichenow).

Picus (*Mesopicus*) *rhodeogaster* FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 180 (Aruscha, Masai Land, German East Africa).

A single adult male, from Aruscha-wa-chini, southwest of Mount Kilimanjaro, seems to be typical of this form, as of course it should be, from so near the type locality. It was taken on October 29, and is molting some of the tail-feathers, though otherwise apparently in perfect plumage.

Family ALAUDIDÆ.

MIRAFRA PÆCILOSTERNA (Reichenow).

Alauda poccilosterna REICHENOW, Ornith. Centralblatt, 1879, p. 155 (Kibaradja, British East Africa).

Three specimens: two from the plains east of Mount Kilimanjaro; and one from Kahé, south of the same mountain. "Iris brown." The last of these, taken September 7, 1888, is much less rufescent throughout than the others, this due apparently to its more freshly molted, possibly immature, condition.

PYRRHULAUDA LEUCOPAREIA (Fischer and Reichenow).

Coraphites leucoparcia FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 55 (Nguruman, Masai Land, German East Africa).

One female, from the plains east of Mount Kilimanjaro, January 6, 1889. It still retains some traces of unfinished molt.

Family PLOCEIDÆ.

TEXTOR NIGER INTERMEDIUS (Cabanis).

Textor intermedius CABANIS, von der Decken's Reisen, III, 1869, p. 32, pl. xi (Kisnani, German East Africa).

One specimen, an adult male, from Taveta, April 26, 1888. "Building nests at this time."

Doctor Reichenow^a and Mr. Neumann^b consider this bird a subspecies of *Textor albirostris* (Vieillot), but, by reason of its red bill and the white on the inner webs of the primaries, it is evidently much more closely related to *Textor niger* (Smith), which latter seems to be specifically distinct from *Textor albirostris*.

DINEMELLIA DINEMELLI (Gray).

Textor dinemelli GRAY, Genera Birds, II, 1844, pl. LXXXVII, fig. 2; idem, 1849, p. 350; RÜPPELL, Syst. Uebers. Vög. Nord-Ost-Afr., 1845, p. 72, pl. xxx (Horsfield, manuscript) (Shoa, Abyssinia).

Three specimens: two from the Useri River, near Mount Kilimanjaro; and one from the plains east of this mountain. "Irides dark

^a Vögel Africas, III, 1904, p. 4.

^b Journ. f. Ornith., 1905, p. 335.

brown. Common, frequenting the scattered *Mimosa* trees in flocks of 8 or 10 individuals."

The specific name of this species is usually attributed to Rüppell, but the latter states in his first published account^a that the plate in Gray's Genera of Birds, on which this bird was labeled "*Textor dinemelli* Horsf.," was previously published;^b and the name therefore must be credited to Gray. The text belonging to this plate, however, seems not to have appeared until 1849, and in it Gray cites Rüppell's plate.^c

AMBLYSPIZA UNICOLOR (Fischer and Reichenow).

Pyrenestes unicolor FISCHER and REICHENOW, Ornith. Centralblatt, 1878, p. 88 (Mombasa, British East Africa; and Zanzibar).

The single specimen, an adult female, from Taveta, May 25, 1888, apparently agrees with the original description.

HYPHANTORNIS RUBIGINOSUS (Rüppell).

Ploceus rubiginosus RÜPPELL, Neue Wirb. Faun. Abyss., Vogel, 1835, p. 93, pl. XXXIII, fig. 1 (Temben, Abyssinia).

One specimen, from the plains east of Mount Kilimanjaro, October 1, 1888. It is an immature male, and corresponds perfectly with Doctor Sharpe's description of the adult female.^d The bill is dull brown above, paler below.

We can discover no satisfactory characters to separate this species generically from *Hyphantornis*.

HYPHANTORNIS CABANISII Peters.

Hyphantornis cabanisii PETERS, Journ. f. Ornith., 1868, p. 133 (Inhambane, Portuguese East Africa).

Five specimens—three adult males and two females—all from Taveta. The bill of the female is not black, as is that of the male, but is dull brown above, dull whitish below. One of the females seems to agree minutely with Doctor Sharpe's description,^e but the other differs in a more yellowish tone above, particularly on the head; in having a clear yellow throat and breast, the latter with no saffron tinge; the lower breast yellow like the throat; the abdomen laterally tinged with the same color; and the under tail-coverts distinctly yellow. "Abundant in the plain, where it breeds in large colonies in the *Mimosa* trees, building a globular hanging nest with a hole in the side."

^a Syst. Uebers. Vög. Nord-Ost-Afr., 1845, p. 72, pl. xxx.

^b "Während ich mich mit der Herausgabe gegenwärtigen Werkchens beschäftigte, hat Herr G. R. Gray eine Abbildung von diesem schönen Webervogel in dem ersten Heft seiner Genera of Birds unter vorstehendem Namen [*Textor dinemelli* Horsf.] veröffentlicht, nach einem von Major Harris vor Kurzem aus Schoa nach England überbrachten Exemplare." Rüppell, *loc. cit.*

^c Genera Birds, II, 1849, p. 350.

^d Cat. Birds Brit. Mus., XIII, 1890, p. 474.

^e Idem, p. 461.

HYPHANTORNIS JACKSONI (Shelley).

Ploceus jacksoni SHELLEY, Ibis, 1888, p. 293, pl. VII (Taveta, British East Africa^a).

Three adult males and one female, all from Taveta. The males of this species may be readily distinguished from those of *Hyphantornis dimidiatus* Salvadori, its nearest ally, by the much greater posterior extent of the chestnut on the lower surface. The female resembles that of *Hyphantornis cabanisi*, but the upper parts, including the wings and tail, are more yellowish, the dusky centers of the feathers less conspicuous; the wings are lighter brown, with edgings broader, those of the superior coverts, secondaries, and tertials being olive yellow, like the color of the back, instead of very pale yellowish, these differences combining to impart to the wings a more uniform appearance; throat, breast, and sides of head more deeply suffused with yellow; under wing-coverts and broad inner margins of the wing-quills rich yellow instead of brownish or yellowish white; feet flesh color instead of dusky.

HYPHANTORNIS NIGRICEPS Layard.

Hyphantornis nigriceps LAYARD, Birds S. Africa, 1867, p. 180 (Kuruman, Bechuana Land, South Africa).

Five specimens (three males, two females), from Taveta.^b "Iris (of male) red."

HYPHANTORNIS BOJERI Cabanis.

Hyphantornis bojeri CABANIS, von der Decken's Reisen, III, 1869, p. 32 (Hartlaub and Finsch, manuscript) (Mombasa, British East Africa).

Three specimens, from Taveta, collected in March, 1888. An immature male differs from the adult of the same sex in having the cheeks, auriculars, throat, and remainder of the lower parts almost uniform yellow, without any decided orange tinge; the upper parts from forehead to tail, including the wings, darker, duller, and more greenish; the head concolor with the back; the bill dull brown. A female that is possibly immature is olive brown above, with a mixture of yellowish and olive green, the back streaked broadly with darker brown, yellowish, and buff; tail greenish olive, edged with yellowish; wings sepia, margined with yellow and olive green; a yellow superciliary stripe; lores dark brown; sides of head and neck mixed yellowish and brownish; lower surface pale yellow, rather darker and duller across the breast, somewhat paler on the abdomen; lining of wing pale yellow; maxilla dark brown; mandible yellowish white.

^aThis is the type locality as given by Captain Shelley in the original description which occurs in the account of a collection made by Mr. F. J. Jackson in the vicinity of Mount Kilimanjaro; and the collector says that the only specimen was brought to him by a little Taveta boy. Doctor Sharpe, however (Cat. Birds Brit. Mus., XIII, 1890, p. 459), gives Manda Island as the type locality.

^bTwo are without data, but are presumably from this locality.

HYPHANTORNIS SCHILLINGSI (Reichenow).

Ploceus schillingsi REICHENOW, Ornith. Monatsber., 1902, p. 158 (Rufu River, German East Africa).

Four specimens of this recently described weaver-bird were obtained by Doctor Abbott. In view of the rarity of the species, the following somewhat detailed descriptions may be of interest.

In general appearance this bird is similar to *Hyphantornis castaneiceps*, but the hind neck is yellow, in conspicuous contrast to the olive-green back; the crown is rich yellow, with a broad occipital band of bay; and there is a narrow collar of orange rufous on the foreneck.

An adult male, Cat. No. 118302, U.S.N.M., from Lake Jipé (south-east of Mount Kilimanjaro), May 20, 1888, may be described as follows: Back and rump uniform yellowish olive green; upper tail-coverts olive yellow; tail like the back, but somewhat brownish, and margined with olive yellow; wings fuscous, the inner webs of the quills basally pale yellow, and distally with broad edgings of the same color; outer vanes of quills margined with golden olive green and olive yellow; lesser coverts wholly olive green, the median coverts broadly edged with golden yellow, the greater series with golden olive; forehead and crown rich golden yellow; hind neck and sides of head and neck gamboge yellow, sharply defined posteriorly against the olive green of the back; occiput with a broad (8 mm.) well-defined band of bay, which is produced as a narrow necklace of orange rufous down the sides of the neck behind the auriculars and across the jugulum, where it widens; with this exception all the under parts, including bend and lining of wing, are rich gamboge yellow; bill black.

Another adult male, from Taveta, has the rufous collar on the foreneck rather obsolete, but is otherwise identical. Still another specimen, from the Useri River, Mount Kilimanjaro, is rather paler on the back; the occipital band is not so deeply bay; and the jugular crescent of orange rufous is broader and more conspicuous.

An immature male, from Taveta, may be described as follows: Upper parts brownish olive green, the rump more brownish, the upper tail-coverts more greenish, the back broadly streaked with dark brown; tail like the upper surface, and edged with yellowish; wings fuscous, with olive green and olive yellow edgings, the quills with pale yellow inner margins; a pale yellow superciliary stripe; a dusky stripe through the eye; sides of head and neck, together with the entire lower surface, including bend and lining of wing, light yellow, somewhat shaded with brownish laterally; maxilla dark horn brown; mandible whitish.

Measurements of three adult males are as below:

Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
		mm.	mm.	mm.	mm.	mm.
Taveta	Mar. 27, 1888	77	54	16	22.5	16
Lake Jipé	May 20, 1888	76	53	17	22.5	16
Useri River	Dec. 13, 1888	79	56.5	17.5	24.5	15.5
Average		77.3	54.5	16.8	23.2	15.8

Doctor Abbott writes that at the time of his visit (May, 1888) the species was breeding in great numbers among the reeds bordering Lake Jipé.

SITAGRA OCULARIA CROCATATA (Hartlaub).

Hyphantornis crocata HARTLAUB, Abhandl. nat. Ver. Bremen, VII, 1881, p. 100 (Magungo, British East Africa).

Four specimens: one from Taveta; one from Maranu, Mount Kilimanjaro, 5,000 feet; two without data. An immature bird has the bill pale brownish. "Irides of male straw yellow." This form differs from true *ocularia* of South Africa as indicated by Doctor Sharpe."

HETERHYPHANTES REICHENOWI (Fischer).

Sycobrotus reichenowi FISCHER, Journ. f. Ornith., 1884, p. 180 (Lake Naivasha, British East Africa).

Three specimens, from Mount Kilimanjaro, at 5,000 feet altitude, June 13 and December 9. "Irides light straw yellow; bill black; feet pinkish flesh color (adult male and female)." An immature male resembles the adult female, but has the upper parts brownish black and much mixed with yellowish olive, particularly on the nape; the bill dull brown, paler below.

GRANATINA IANTHINOASTRA (Reichenow).

Uraeginthus ianthinogaster REICHENOW, Ornith. Centralblatt, 1879, p. 114 (Massa, British East Africa).

Two specimens, an adult and an immature male, of this rare weaver-bird were taken by Doctor Abbott on the plains east of Mount Kilimanjaro. "Bill, irides, and the bare skin encircling the eyes, red (in adult male)." The immature male differs considerably from the adult, and may be described as follows:

Head and cervix cinnamon rufous; back and rump dull cinnamon; wings fuscous, margined with dull reddish cinnamon; upper tail-coverts bright blue; tail brownish black, the outer feathers narrowly edged with dark cinnamon brown; orbital region bright blue; sides of neck like the crown; auriculars the same, but darker; lower surface cinnamon rufous, much paler posteriorly.

ESTRILDA RHODOPYGA Sundevall.

Estrilda rhodopyga SUNDEVALL, Öfv. K. Vet.-Akad. Förh. Stockholm, 1850, p. 126 (Eastern Africa).

Four specimens from Taveta, three of them immature. The adult female, which is the only adult we have for comparison, has the lower tail-coverts deep buff, much mottled with brown, and with scarcely a tinge of reddish; the cheeks, chin, and upper throat are buff instead of white. The young birds (both sexes) lack the crimson line through the eye, and the vermiculations of the adult, and have the crissum only slightly suffused with reddish. The cheeks, chin, and throat are buffy, like those of the adult female.

ESTRILDA ASTRILD MINOR (Cabanis).

Habropygga minor CABANIS, Journ. f. Ornith., 1878, p. 229 (Voi River, British East Africa).

Four specimens, from Maranu, Mount Kilimanjaro, 5,000 feet. "Very common everywhere on the mountain up to 6,000 feet." The females of this well differentiated race are duller and more brownish throughout than the males.

ESTRILDA BENGALUS (Linnæus).

Fringilla bengalus LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 323 ("Bengala;" locality erroneous; probably from Senegal).

Estrelida phanicotis SWAINSON, Birds West Afr., I, 1837, p. 192, pl. xiv (Senegal).

A single young male, from Taveta, August 14, 1888. It is almost adult: The cheeks and ear-coverts are blue—the latter mixed with brown and crimson.

The specific name *phanicotis*, by which this bird has been commonly known, is long antedated by *bengalus* of Linnaeus, and there appears to be no valid reason why the latter should not be employed.

There seem to be no structural characters by which the genus *Uræginthus* can be distinguished from *Estrilda*. Doctor Reichenow's separation^a is based on color.

ESTRILDA CYANOCEPHALA Richmond.

Estrilda cyanocephala RICHMOND, Auk, XIV, 1897, p. 157 (Useri River, near Mount Kilimanjaro, East Africa).

Two adult males, one from the Useri River, near Mount Kilimanjaro, the other from the plains east of the same mountain. "Bill and irides red." The characters of this very distinct species, one of Doctor Abbott's most interesting discoveries in Africa, have been already sufficiently detailed by Doctor Richmond,^b rendering unnecessary their repetition here.

^a Vögel Africas, III, 1904, pp. 105, 206.

^b Auk, XIV, 1897, pp. 157-158.

ESTRILDA SUBFLAVA (Vieillot).

Fringilla subflava VIEILLOT, Nouv. Dict. d'Hist. Nat., XXX, 1819, p. 575 (Senegal).

Three specimens—two males and a female—from Aruscha-wa-chini, southwest of Kilimanjaro, taken November, 1, 1888.

It seems hardly advisable to recognize a genus *Sporæginthus*, for the supposed differences, at most slight, are apparently all obliterated by intermediate species.

NIGRITA DIABOLICA (Reichenow and Neumann).

Atopornis diabolicus REICHENOW and NEUMANN, Ornith. Monatsber., 1895, p. 74 (Kifinika, 3,000 m., Mount Kilimanjaro, German East Africa).

One adult female of this rare species was taken by Doctor Abbott, on Mount Kilimanjaro, at 9,000 feet, July 30, 1888.

HYPOCHERA AMAUROPTERYX Sharpe.

Hypochæra amauropteryx SHARPE, Cat. Birds Brit. Mus., XIII, 1890, p. 309 (South Africa to the Zambesi River, Mozambique, and Ovambo Land).

One adult male, from Taveta, April 18, 1889.

COCCOPYGIA DUFRESNI KILIMENSIS (Sharpe).

Coccopygia quartinia subsp. a. *kilimensis* SHARPE, Cat. Birds Brit. Mus., XIII, 1890, p. 307 (Mount Kilimanjaro, East Africa).

Five specimens, from Mount Kilimanjaro, at 5,000 feet. Three of them have the back finely, but distinctly, vermiculated with dusky.

The name *Neisna* Bonaparte^a has been used for this genus by Doctor Reichenow;^b but the type of *Neisna* is the first species mentioned, *Fringilla subflava* Vieillot, as fixed by Doctor Sharpe.^c This makes *Neisna* a synonym of *Estrilda*; and *Coccopygia* Reichenbach therefore becomes the correct name for the present group.

AMADINA FASCIATA (Gmelin).

Loxia fasciata GMELIN, Syst. Nat., I, ii, 1788, p. 859 (Africa).

Two adult females, from the plains east of Mount Kilimanjaro, taken December 11, 1888. There are pronounced traces of chestnut on the abdomen in both these specimens.

^a Consp. Avium, I, 1850, p. 460.

^b Vögel Africas, III, 1904, p. 203.

^c Cat. Birds Brit. Mus., XIII, 1890, p. 305.

HYPARGOS NIVEOGUTTATUS (Peters).

Spermophaga niveoguttata PETERS, Journ. f. Ornith., 1868, p. 133 (Inhambane, Portuguese East Africa).

Ten specimens: four without labels; the rest from Mount Kilimanjaro (5,000 feet); Taveta; and Kahé, south of Kilimanjaro. In none of these is the *rump* crimson,^a but it is brown, like the back, the crimson being restricted to the upper tail-coverts. The adult females differ from the males in their lighter upper parts; the sides of the head are brownish gray instead of crimson; the crimson on the breast, throat, and sides of neck is paler and diluted with tawny; the chin is tawny without any crimson; and the black of the posterior lower surface is replaced by brownish slate. The immature female resembles the adult, but has less of crimson on throat, breast, and sides of neck. A young male is in general like the adult female, but is darker throughout, particularly on the throat and breast; the abdomen is also more blackish; and only a few of the crimson feathers of the head and the anterior lower parts have made their appearance. "Iris (of adult male) dark brown; feet dark flesh color; bare skin around eyes light blue. Iris (of adult female) brown; bill blue, black at tip; feet slate blue; bare skin around eyes light blue."

SPERMESTES CUCULLATUS SCUTATUS (Heuglin).

Spermestes scutatus HEUGLIN, Journ. f. Ornith., 1863, p. 18 (Dembea, Abyssinia).

Two specimens: an adult female from Mount Kilimanjaro (5,000 feet), December 29, 1889; and an immature bird without data. "Bill (of adult female) black above, slate blue below."

LEPIDOPYGIA NIGRICEPS (Cassin).

Spermestes nigriceps CASSIN, Proc. Acad. Nat. Sci. Phila., 1852, p. 185 (Zanzibar East Africa).

Four specimens, all adults: two without labels; the others from Taveta, March 22, 1888.

The genus *Spermestes*,^b as commonly constituted, contains two well differentiated types of structure which are quite deserving of generic separation. True *Spermestes* should be restricted to *Spermestes cucullatus* Swainson and *Spermestes cucullatus scutatus* (Heuglin), and the other species be called *Lepidopygia*.^c The latter differs from *Spermestes* in having the second primary of about the same width as the

^aSee Sharpe, Cat. Birds Brit. Mus., XIII, 1890, p. 274.

^bSwainson, Birds West Afr., I, 1837, p. 201 (type, *Spermestes cucullata* Swainson).

^cReichenbach, Singvögel, 1863, p. 48 (type, *Pyrhula nana* Pucheran).

third, whereas in *Spermestes* it is much narrowed, particularly toward the tip; the cutting edge of the maxilla much more lobed or festooned basally, which makes its outline very like an elongated *S*, while in *Spermestes* it is almost a regular though rather slight concave curve; and the tertials much shorter, *not* reaching, as in *Spermestes*, very nearly or quite to the ends of the primaries.

The species to be referred to *Lepidopygia* are as follows:

Lepidopygia bicolor bicolor (Fraser).

Lepidopygia bicolor punctata (Heuglin).

Lepidopygia poensis poensis (Fraser).

Lepidopygia poensis stigmatophora (Reichenow).

Lepidopygia nigriceps nigriceps (Cassin).

Lepidopygia nigriceps minor (Erlanger).

ODONTOSPIZA,^a new genus.

Chars. gen.—Similar to *Spermestes* Swainson, but bill more turgid and more conical; the maxillar tomium with a well-defined obtusely angular tooth-like lobe near the middle; the mandibular tomium with a sharply defined basal angle, the edge straight from the gape to this point, and straight or even slightly concave thence to the tip, whereas in *Spermestes* the cutting edge of the mandible is a more or less regular convex curve from gape to tip, the basal angle being much rounded and comparatively inconspicuous; nostrils not set into the corneous base of the maxilla, as in *Spermestes*, but wholly posterior, so that their anterior margin, as well as the rest of the latero-basal outline of the maxilla, is much less concave; nasal fossæ quite filled with short feathers which completely cover the nares; tail longer, about three-fourths instead of two-thirds the length of wing; tertials much shorter.

Type.—*Pitylia caniceps* Reichenow.

This peculiar species was placed by Doctor Sharpe in the oriental genus *Uroloncha*,^b but it is manifestly out of place in such company, for it differs from the members of that group in its shorter, more turgid and more conical bill; toothed maxillar tomium; feather-hidden nostrils which do not open in the horny sheath of the bill; less concave latero-basal outline of maxilla; moderately rounded tail without much projecting narrowed central feathers; and a much narrowed second primary. From *Lepidopygia* it may be distinguished by the same various peculiarities of bill and nostrils that separate it from *Spermestes*, and as well by the laterally much reduced second primary. The type is the only species referable to this new genus.

^a ὀδόντῃς, dens; στίζα, fringilla.

^b Cat. Birds Brit. Mus., XIII, 1890, p. 356.

ODONTOSPIZA CANICEPS (Reichenow).

Pitylia caniceps REICHENOW, Ornith. Centralblatt, 1879, p. 139 (Massa, British East Africa).

One specimen, an adult female, from the plains east of Mount Kilimanjaro, August 25, 1888. It apparently does not differ from the adult male.

QUELEA CARDINALIS (Hartlaub).

Hyphantica cardinalis HARTLAUB, Journ. f. Ornith., 1880, p. 325 (Lado, Upper White Nile, British Equatorial Africa).

Two adult males, both from Taveta.

QUELEA SANGUINIROSTRIS ÆTHIOPICA (Sundevall).

Ploceus sanguinirostris var. *major* (*Pl[oceus]æthiopicus*) SUNDEVALL Öfv. k. Vet.-Akad. Förh. Stockholm, 1850, p. 126 (Sennaar, Egyptian Sudan).

Six specimens, from Taveta and the plains east of Mount Kilimanjaro. At the latter place Doctor Abbott found them in very large flocks, September 22, 1888. The immature male seems to be quite the same as the adult female, except for rather paler upper parts.

PSEUDONIGRITA CABANISI CABANISI (Fischer and Reichenow).

Nigrita cabanisi FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 54 (Pare Mountains, Masai Land, German East Africa).

One specimen, an adult male, of this rare and interesting species, from the plains east of Mount Kilimanjaro, October 3, 1888. "Nesting at the present time, in colonies of 20 to 30; building a globular, hanging nest." Mr. F. J. Jackson found a colony nest building in March.^a

HYPERANTHUS CAPENSIS XANTHOMELAS (Rüppell).

Euplectes xanthomelas RÜPPELL, Nene Wirb. Faun. Abyss., Vögel, 1835, p. 94 (Temben and Simen, Abyssinia).

Two specimens, an adult and an immature male, from the foot of Mount Kilimanjaro, at 3,000 feet. This immature male closely resembles the adult female.

Doctor Reichenow^b is quite right in separating this species and *Hyperanthuscapensis* (Linnaeus) from *Pyromelana*; for the lengthened, rounded tail, which is from two-thirds to three-fourths the length of the wing, is very different from the truncate tail of *Pyromelana*, scarcely more than half as long as the wing.

^a Shelley, Ibis, 1888, p. 292.

^b Vögel Africas, III, 1904, p. 125.

The name *Euplectes* Swainson,^a employed by Doctor Reichenow^b for this group, is preoccupied in Coleoptera by *Euplectus* Leach,^c for which reason it was long ago rejected by Doctor Sharpe.^d It should be replaced by *Hyperanthus* Gistel.^e

PYROMELANA FLAMMICEPS (Swainson).

Euplectes flammiceps SWAINSON, Birds West Afr., 1837, I, p. 186, pl. XIII (Senegal).

Six specimens, all in winter plumage: from Mount Kilimanjaro, at 5,000 feet altitude, November 10 and 21, 1888; and Taveta, September, 1888. In the individuals of this series there is a great deal of difference in the depth of the ochraceous suffusion both on the upper and lower parts, and this does not appear to be due to sex.

COLIUSPASSER EQUUS (Hartlaub).

Vidua eques HARTLAUB, Proc. Zool. Soc. Lond., 1863, p. 106, pl. xv (Kazeh, Victoria Nyanza, German East Africa).

One specimen, an adult male, from Taveta, April 26, 1888.

LINURA FISCHERI Reichenow.

Linura fischeri REICHENOW, Ornith. Centralblatt, 1882, p. 91 (Usegua, German East Africa).

A single adult female, from Taveta, November 8, 1888. This differs from the female of *Vidua macroura* (= *principalis*) in having the tawny of the vertex and post-superciliary stripe replaced by buff or whitish; the dark parts of the plumage everywhere brown, not black, though the pattern of coloration is practically the same; and the breast of a duller ochraceous.

VIDUA MACROURA (Pallas).

Fringilla macroura PALLAS, in Vroeg's Catal., 1764, Adumbrat., p. 3 ("East Indies;" locality erroneous; should be Africa).

Emberiza serena LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 312 (no locality given).

Vidua principalis AUTHORS.

Five specimens, from Taveta and Mount Kilimanjaro (Maranu, 5,000 feet). An immature male just acquiring its lengthened tail-feathers is, in color, quite like the adult female, though more extensively black above and with the rump partly white.

^a Birds West Afr., I, 1837, p. 180 (type, *Loxia capensis* Linnæus).

^b Vögel Africas, III, 1904, p. 125.

^c Zool. Miscell., III, 1817, pp. 80, 82.

^d Cat. Birds Brit. Mus., XIII, 1890, p. 227.

^e Naturg. Thierr. höh. Schul., 1848, p. IX (nom. emend. pro. *Euplectes*).

The specific name *principalis*,^a by which this bird has been generally known, should give place to *macroura*,^b as already clearly shown by Dr. C. W. Richmond.^c

Family STURNIDÆ.

BUPHAGUS AFRICANUS Linnæus.

Buphaga africana LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 154 (Senegal).

One adult male, from the Useri River, Mount Kilimanjaro, July 10, 1889. Another specimen in the U. S. National Museum, from the Transvaal, is apparently immature, as the bill lacks the red spot; the rump is duller; the other upper parts less rufescent brown; and the lower surface more grayish, most of the posterior portion, including the inferior tail-coverts, being light brownish gray instead of bright ochraceous.

The name of this genus is usually spelled *Buphaga*, and credited to Linnaeus;^d but the *Buphagus* of Brisson^e is of identical application and earlier date. Doctor Reichenow has made this change,^f and should be followed by all who accept Brissonian genera.

SPREO SUPERBUS (Rüppell).

Lamprolornis superbus RÜPPELL, Syst. Uebers. Vög. Nord.-Ost.-Afr., 1845, p. 65, pl. XXVI (Shoa, Abyssinia).

Three specimens, from the plains of Kilimanjaro, August 25, 1888, and the plains east of Mount Kilimanjaro, October 3 and 6, 1888. An immature male differs from the adult in having the throat, breast, and entire upper parts, excepting the wings and tail, dull blackish, with only slight metallic reflections; the superior wing-coverts without velvety black spots; the white breast-band barely indicated; and the posterior lower parts paler rufous.

SPREO HILDEBRANDTI (Cabanis).

Notauges hildebrandti CABANIS, Journ. f. Ornith., 1878, p. 233, pl. III, fig. 1 (Ukamba, British East Africa).

One immature specimen from the plains of Taveta, July 1, 1888, which differs from the adult in having the upper parts dull black with comparatively inconsiderable metallic sheen; the wings and tail duller; and the entire lower surface rufous, the throat and breast darker and more grayish than the abdomen. Doctor Abbott reported the species common at Taveta in July, 1888.

^a *Emberiza principalis* Linnaeus, Syst. Nat., 12th ed., I, 1766, p. 313.

^b Pallas in Vroeg's Catal., 1764, Adumbrat., p. 3.

^c Smithsonian. Quart., II, 1905, p. 345.

^d Syst. Nat., 12th ed., I, 1766, p. 154.

^e Ornith., II, 1760, p. 437.

^f Vögel Africas, II, 1903, p. 665.

The generic name *Spreo* has commonly been credited to Lesson,^a but he used it only in a vernacular sense. In his "Traité" he sets out the group headings, corresponding to our generic or subgeneric divisions, with the vernacular name in capitals, followed by the technical term in small italic letters—for example:

IV^e. Sous-genre. MERLE; *Merula*.

In the case of *Spreo*, however, the Latin name is omitted, thus:

III^e. Sous-genre. SPREO.

Under such circumstances this term, at least as dating from Lesson, can, of course, not be accepted. Bonaparte was apparently the first author to employ *Spreo* in a correct nomenclatural form,^b and the name thus fortunately continues prior to *Notaugetes* Cabanis.^c

ARIZELOPSAR,^d new genus.

Chars. gen.—Similar to *Spreo* Lesson, but bill relatively much broader; feet falling much short of the end of tail, the combined length of tarsus and middle toe with claw only about two-thirds the length of the tail; tail emarginate and nearly three-fourths the length of the wing.

Type.—*Pholidauges femoralis* Richmond.

From *Cinnyricinclus* (= *Pholidauges*), in which the type and sole species of this new genus was placed by its describer,^e *Arizelopsar* differs chiefly as follows: Feathers of forehead not extending to distal end of nasal fossæ; outermost (spurious) primary broad, and longer than primary coverts; tarsus decidedly longer than middle toe and claw; tail about three-fourths of wing; and four primaries sinuate on their outer webs. Doctor Reichenow has referred *Pholidauges femoralis* to *Spreo*,^f but that it is almost as much out of place in that genus as in *Cinnyricinclus* the above diagnosis indicates. An additional differential character is the absence of the rounded notch on the distal third of the inner webs of several of the outer primaries, which is present in *Spreo*.

The *Spreo albicapillus* of Blyth,^g which has been referred to *Heteropsar* by Doctor Sharpe,^h seems not to belong to either of these groups, being in many of its characters very much nearer *Arizelopsar*, from which, however, it so much differs in its long, much rounded, almost graduated tail, not to mention its peculiar coloration, that its generic separation seems advisable.

^a Traité d'Orn., 1831, p. 407.

^b Consp. Avium, I, 1850, p. 416.

^c Mus. Hein., I, 1851, p. 198 (type, *Turdus bicolor* Gmelin).

^d ἀρίζηλος, evidens; ψάρ, sturnus.

^e Richmond, Auk, XIV, 1897, p. 160.

^f Vögel Africas, II, 1903, p. 678.

^g Journ. As. Soc. Bengal, XXIV, 1856, p. 301 (Somali Land).

^h Cat. Birds Brit. Mus., XIII, 1890, p. 186.

From *Spreo* it differs most conspicuously in its long tail and abbreviated feet. Its characters are more fully shown in the following comparative diagnoses:

1. *Poneropsar*,^a new genus.^b

Bill rather broad, the feathering of forehead not extending to anterior end of nasal fossæ; outermost (first) primary broad, and longer than primary coverts; tail much rounded, about three-fourths the length of wing; feet not reaching to end of tail; tarsus decidedly longer than middle toe and claw; hind toe longer than middle toe; metallic plumage of upper surface not stiffened and scale-like.

Species:

Poneropsar albicapillus (Blyth).

2. *Arizelopsar* Oberholser.^c

Bill broad, the feathering of forehead not extending to anterior end of nasal fossæ; four primaries sinuate on outer webs, no notch on inner webs; first primary broad, and longer than primary coverts; tail emarginate, and about three-fourths of wing; feet falling much short of end of tail, the tarsus, middle toe, and middle claw combined not over two-thirds the length of tail; tarsus decidedly longer than middle toe with claw; hind toe longer than middle toe; metallic plumage of upper parts not stiffened and scale-like.

Species:

Arizelopsar femoralis (Richmond).

3. *Spreo* Bonaparte.^d

Bill comparatively narrow, the frontal feathering not extending to anterior end of nasal fossæ; four primaries sinuate on outer webs, with also a conspicuous notch on inner webs; first primary broad, and longer than the primary coverts; tail rounded, less than two-thirds the length of wing; feet reaching nearly or quite to end of tail, the combined length of tarsus, middle toe, and middle claw about three-fourths the length of tail; tarsus decidedly longer than middle toe and claw; hind toe longer than middle toe; metallic plumage of upper parts not stiffened and scale-like.

Species:

Spreo bicolor (Gmelin).

Spreo superbus (Rüppell).

Spreo pulcher (Müller).

Spreo hildebrandti hildebrandti (Cabanis).

Spreo hildebrandti shelleyi (Sharpe).

Spreo fischeri (Reichenow).

4. *Heteropsar* Sharpe.^e

Bill rather narrow, the frontal feathering not extending to anterior end of nasal fossæ; first primary narrow, and not longer than

^a *πορνιός*, difficilis; *ψάρ*, sturnus.

^b Type, *Spreo albicapillus* Blyth.

^c See p. 887.

^d *Consp. Avium*, I, 1850, p. 416 (type, *Turdus bicolor* Gmelin).

^e *Cat. Birds Brit. Mus.*, XIII, 1890, p. 185 (type, *Lamprocolius acuticaudus* Bocage).

primary coverts; tail graduated, about four-fifths the length of wing; feet not reaching to end of tail; tarsus decidedly longer than middle toe and claw; hind toe longer than middle toe; metallic feathers of upper surface not stiffened or scale-like.

Species:

Heteropsar acuticaudus (Bocage).

5. *Cinnyricinclus* Lesson.^a

Bill rather broad, the frontal feathering extending along the upper sides of the nasal fossæ to their anterior ends; three primaries sinuate on their outer webs, no notch on inner webs; outermost primary narrow, and not longer than primary coverts; tail emarginate, and less than two-thirds the length of wing; feet falling much short of end of tail, the tarsus and middle toe with claw combined not over two-thirds the length of tail; tarsus not decidedly longer than middle toe and claw; hind toe not longer than middle toe; metallic feathers of upper parts and breast stiffened and scale-like.

Species:

Cinnyricinclus leucogaster leucogaster (Gmelin).

Cinnyricinclus leucogaster verreauxi (Finsch and Hartlaub).

The subjoined key to these five genera may serve more clearly to exhibit some of their most prominent characteristics:

A. Outermost (first) primary not longer than primary coverts.

a. Tarsus not decidedly longer than middle toe and claw; tail

emarginate, less than two-thirds the length of wing.....*Cinnyricinclus*

a'. Tarsus decidedly longer than middle toe and claw; tail much

rounded and more than two-thirds the length of wing.....*Heteropsar*

B. Outermost (first) primary longer than primary coverts.

a. Tail less than two-thirds of wing; feet reaching to about end of tail.....*Spreo*

a'. Tail more than two-thirds of wing; feet not reaching to end of tail.

b. Tail emarginate.....*Arizelopsar*

b'. Tail strongly rounded.....*Poncropsar*

ARIZELOPSAR FEMORALIS (Richmond).

Pholidauges femoralis RICHMOND; Auk, XIV, 1897, p. 160 (Mount Kilimanjaro, East Africa).

A single adult male, the type of this very distinct species, was taken by Doctor Abbott on Mount Kilimanjaro, at 6,000 feet, June 12, 1888.

AMYDRUS MORIO RUPPELLII (Verreaux).

Amydrus ruppellii VERREAUX, in Chenu., Encycl. Méth., V, 1856, p. 166 (Abyssinia).

Two specimens—female and male—from Mount Kilimanjaro, and Mandara's, Mount Kilimanjaro, 5,000 feet, respectively. These belong without doubt to the well-differentiated subspecies *ruppellii* of north-eastern Africa, which differs from true *A. morio* in longer wing and

^aRev. Zool., 1840, p. 272 (type, *Turdus leucogaster* Gmelin).

tail, stouter bill, and less purplish sheen of the metallic portions of the plumage. So far as our material indicates, the birds from British and German East Africa are not different enough from *ruppellii* to warrant the recognition of another and intermediate subspecies *shelleyi*.^a

PYRRHOICHEIRA WALLERI WALLERI (Shelley).

Amydrus walleri SHELLEY, Ibis, 1880, p. 335, pl. VIII (Usambara Mts., German East Africa).

A single adult female, from Mount Kilimanjaro, 5,000 feet, September, 1889. It has broad terminal shaft streaks of metallic greenish black on the dark gray feathers of the hind neck; otherwise it does not differ from descriptions.

This species is out of place in the genus *Amydrus*, and belongs without doubt in *Pyrrhocheira*, where it has been placed by Doctor Reichenow.^b

STILBOPSAR STUHLMANNI Reichenow.

Stilbopsar stuhlmanni REICHENOW, Ornith. Monatsber., 1893, p. 31 (Badjua, Albert Nyanza, British East Africa).

Amydrus? dubius RICHMOND, Auk, 1897, p. 158 (Taveta, British East Africa).

Pooptera greyi JACKSON, Bull. Brit. Orn. Club, VIII, 1899, No. LXIII, p. 1 (Nandi, British East Africa).

One adult female, from Taveta, August 17, 1888. "Iris light yellow." Doctor Richmond's *Amydrus dubius*,^c based on this specimen, is apparently the same as *Stilbopsar stuhlmanni* Reichenow,^d as is also *Pooptera greyi* Jackson; and *Stilbopsar kenricki* (Shelley)^e is dubiously distinct.

COSMOPSARUS REGIUS Reichenow.

Cosmopsarus regius REICHENOW, Ornith. Centralblatt, 1879, p. 108 (Massa, British East Africa).

Three specimens of this beautiful starling were obtained by Doctor Abbott on the plains east of Mount Kilimanjaro, October 5, 1888. One of these has just molted into the adult plumage, and has still some brown feathers among the metallic ones of the under wing-coverts. There are also fine black spots on the tips of some of the greater and median wing-coverts, though whether or not this is an evidence of immaturity there is nothing to determine; but these spots are not present in the two other specimens. "Iris white." The female apparently does not differ in color from the male, but is evidently smaller, as our birds, which are all females, measure, respectively, 117, 119, and 126 millimeters in length of wing.

^a*Amydrus morio shelleyi* Hartert, Cat. Vogelsamml. Mus. Senckenb., 1891, p. 75.

^bVögel Africas, II, 1903, p. 697.

^cAuk, XIV, 1897, p. 158.

^dOrnith. Monatsber., 1893, p. 31.

^e*Pooptera kenricki* SHELLEY, Bull. Brit. Orn. Club, III, 1894, No. XVIII, p. xlii (Usambara Mts., German East Africa).

Family PYCNONOTIDÆ.

ARIZELOCICHLA ^a NIGRICEPS (Shelley)

Xenocichla nigriceps SHELLEY, Proc. Zool. Soc. Lond., 1889, p. 362 (Mount Kilimanjaro, East Africa).

Arizelocichla nigriceps OBERHOLSER, Smithson. Quart., III, 1905, p. 164.

Eight specimens, all from Mount Kilimanjaro, at altitudes of 6,000, 7,000, and 10,000 feet, collected in April, May, June, and August, 1888. The females are much smaller than the males, but in other respects are indistinguishable.

ARIZELOCICHLA STRIIFACIES (Reichenow and Neumann).

Xenocichla striifacies REICHENOW and NEUMANN, Ornith. Monatsber., 1895, p. 74 (Marangu, Mount Kilimanjaro).

Arizelocichla striifacies OBERHOLSER, Smithson. Quart., III, 1905, p. 164.

One adult female of this rare species was obtained by Doctor Abbott at an altitude of 5,000 feet on Mount Kilimanjaro, October 16, 1889. It agrees perfectly with Doctor Reichenow's descriptions,^b except for the lack of most of the fine white streaking on the chin, this part being instead narrowly barred with whitish.

PYCNONOTUS LAYARDI MICRUS, new subspecies.

Chirs. subsp.—Similar to *Pycnonotus layardi layardi*, but very much smaller.

Description.—Type, adult male, Cat. No. 117995, U.S.N.M.; Taveta, British East Africa, March 22, 1888; Dr. W. L. Abbott. Pileum, chin, and sides of head brownish black; throat, breast, sides of neck, and remainder of upper parts, including wings and tail, fuscous brown, the breast rather lighter, the tail darker, and the feathers nearly everywhere with paler tips which on the breast and outer tail-feathers become whitish; lower breast and abdomen white, the sides and flanks washed with brownish; crissum bright yellow; under wing-coverts brownish white, washed with yellow along the edge of the wing.

Doctor Sharpe long ago called attention to the difference characterizing the birds of this species found in East Africa,^c but no name appears yet to have been bestowed upon this race. Although practically the same in color, the birds from East Africa exhibit such a wide and apparently quite constant discrepancy in size from those of the southern part of the continent that their subspecific separation seems justified. This may be seen from the subjoined measurements.

^a See Oberholser, Smithson. Quart., III, 1905, p. 163.

^b Ornith. Monatsber., 1895, p. 74; Vögel Africas, III, 1904, p. 391.

^c Cat. Birds Brit. Mus., VI, 1881, p. 133.

Pycnonotus layardi layardi.

Sex.	Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
			mm.	mm.	mm.	mm.	mm.
Male ..	Pretoria, Transvaal	July —, 1895	101	90	17.5	21	16
Male ..	Umzila's Kingdom, South Africa.....	.....	97	85	16.5	22.5	15.5
Male ..	Natal .....	.....	99	90	17	24.5	16
Male ..	Grahamstown, Cape Colony.....	May —, 1895	98	91	18.5	23.5	16
Male ..	do	— —, 1896	100	93	17	23	16
Average			99	89.8	17.3	22.9	15.9

Pycnonotus layardi micrus.

			mm.	mm.	mm.	mm.	mm.
Male ..	Taveta, British East Africa.....	May 25, 1888	89	77	15	22	14
Male ..	do. "	Mar. 22, 1888	91.5	80	14	19	13
Male ..	Maranu, Mount Kilimanjaro, East Africa	Apr. 13, 1888	84	73	14.5	22	14.5
Male ..	do	Apr. 19, 1888	94	83	15	21.5	14.5
Male ..	Mount Kilimanjaro, East Africa.....	June 8, 1888	85	80	14	21	14
Average			88.7	78.6	14.5	21.1	14

^aType.

The type of *Pycnonotus layardi layardi* came from Rustenburg, Transvaal,^a and examples from this region are like those from Cape Colony. The range of *Pycnonotus layardi micrus* extends from south-eastern British East Africa (Mombasa) south through German East Africa, and probably to the Zambesi River, though no specimens are at hand to determine the exact limits of its range in this direction.

Ten specimens in all were obtained by Doctor Abbott, at the following localities: Kidudwe, 90 miles inland from Zanzibar; Taveta; and Maranu, Mount Kilimanjaro, 5,000 feet, where the collector reports it common. These examples are very uniform in coloration, the chief essential difference observable being in the extent of blackish on the chin and sides of the head, a variation apparently not influenced by sex, age, or season. Much worn birds are rather more rufescent; and an immature, taken April 13, 1888, differs similarly, particularly on the cervix, rump, and superior wing coverts, as well as additionally in the much less blackish pileum.

PHYLLASTREPHUS STREPITANS (Reichenow).

Criniger strepitans REICHENOW, Ornith. Centralblatt, 1879, p. 139 (Malindi, British East Africa).

One specimen, without more definite locality than "East Africa," but probably from the Kilimanjaro region. This example has been identified as *Phyllastrephus pauper* by Dr. R. B. Sharpe, but it seems to agree better with *P. strepitans*. If *Phyllastrephus pauper*,^b by

^a Ayres, Ibis, 1879, p. 390.

^b *Phyllostrophus pauper* Sharpe, Proc. Zool. Soc. Lond., 1895, p. 489 (Shebeli, western Somali Land).

reason of its smaller size, differs from *P. strepitans*, it is at most only a subspecies and should be called *Phyllastrephus strepitans rufescens* (Hartlaub),^a which name applies quite certainly to the same bird and is of earlier date. Another synonym is probably *P. parvus* Fischer and Reichenow.^b

PHYLLASTREPHUS CERVINIVENTRIS Shelley.

Phyllostrophus cerviniventris SHELLEY, Ibis, 1894, p. 10, pl. II, fig. 1 (Zomba and Tschiromo, Nyassa Land, British Central Africa).

One adult female, from Taveta, taken August 14, 1888.

PHYLLASTREPHUS PLACIDUS (Shelley).

Xenocichla placida SHELLEY, Proc. Zool. Soc. Lond., 1889, p. 363 (Mount Kilimanjaro, East Africa).

Five adults, from Taveta, and from Mount Kilimanjaro at 6,000 feet; taken in April, May, and August, 1888. These exhibit little individual color variation; the females are considerably smaller than the males, but appear to be otherwise identical.

Family TIMALIIDÆ.

ARGYA SATURATA Sharpe.

Argya saturata SHARPE, Proc. Zool. Soc. Lond., 1895, p. 488 (Zanzibar, East Africa).

Two specimens—male and female—from Taveta, September 11, 1888. "Bill and feet white; iris yellowish white."

COSSYPHA NATALENSIS Smith.

Cossypha natalensis SMITH, Ill. Zool. S. Afr., 1840, pl. LX, (Port Natal [Durban], Natal, South Africa).

Five specimens: from Mount Kilimanjaro, 5,000 feet; Taveta; and the Usiri River. The three in adult plumage vary but slightly except in the amount of fulvous on the back and of blackish cross lines on the pileum, though one has ochraceous tips to the tertials and some of the wing coverts, evidently retained from the juvenal plumage. "Bill black; iris brown; feet dark brown." The two young birds, taken respectively October 5, 1888, and December 7, 1889, are in a plumage apparently undescribed and differ from the adult as follows: Top and sides of head and neck brownish black with broad shaft markings of deep ochraceous and tawny; most feathers of rump and upper tail-coverts narrowly tipped with blackish; tertials, scapulars,

^a *Phyllastrephus rufescens* Hartlaub, Ornith. Centralblatt, 1882, p. 91 (Central Africa, collected by Emin Bey).

^b *Phyllostrophus parvus* Fischer and Reichenow, Journ. f. Ornith., 1884, p. 262 (Murentât, near Lake Naivasha, British East Africa).

greater and median coverts with terminal spots of ochraceous; chin and upper throat pale buff with fine, irregular streaks of blackish; jugulum and breast buff with coarsely squamate markings of brownish black; sides of breast deep ochraceous, similarly mottled; a few scattered blackish squamations on the rest of the lower surface; middle of abdomen pale ochraceous or even whitish.

COSSYPHA CAFFRA IOLÆMA Reichenow.

Cossypha caffra iolæma REICHENOW, Ornith. Monatsber., 1900, p. 5 (Nyassa Land to Mount Kilimanjaro).

Five specimens from Mount Kilimanjaro, at altitudes of 5,000 and 6,000 feet. "Common in bushy places." Compared with a series of South African specimens of true *Cossypha caffra*, these bear out the characters claimed by Doctor Reichenow for *Cossypha c. iolæma*,^a and moreover show it to be an excellent race.

COSSYPHA HEUGLINI INTERMEDIA (Cabanis).

Bessornis intermedia CABANIS, von der Decken's Reisen, III, 1869, Pt. 1, p. 22, pl. XII (coast of East Africa).

One adult male from Mount Kilimanjaro, at 5,000 feet, July 22, 1888. This appears to be typical of the southern race *intermedia* which differs from true *heuglini* chiefly in much smaller size and darker lower surface.

The genus *Cossypha*, though commonly considered to belong to the Timaliidae, has been recently placed in the Turdidae by Doctor Sharpe,^b where, however, by reason of its scutellate tarsi it seems not satisfactorily located.

Family TURDIDÆ.

MERULA DECKENI (Cabanis).

Turdus deckeni CABANIS, Journ. f. Ornith., 1868, p. 412 (type locality not known; probably somewhere in East Africa).

Three specimens, two adults and one young, from Mount Kilimanjaro, at 5,000 feet. One of the adults is paler throughout than the other, this particularly conspicuous on abdomen and crissum, and may be the female, though marked male. The juvenal example, taken August 4, 1888, is rather more rufescent brown above, especially on the wings, the back with scarcely noticeable darker edgings; darker, more rufescent on the throat and breast; paler on abdomen; and has most of the lower surface spotted or barred with blackish.

^a Ornith. Monatsber., 1900, p. 5.

^b Hand-List Gen. and Spec. Birds, IV, 1903, p. 162.

The two adult males measure as follows:

Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
	mm.	mm.	mm.	mm.	mm.
Oct. 18, 1889.....	117	101	21.5	34	23.5
Do.....	123	101	20.5	34.5	23

LUSCINIA MEGARHYNCHA Brehm.

Luscinia megarhynchos BREHM, Handb. Naturg. Vög. Deutschl., 1831, p. 356 (Germany).

Daulias luscinia AUTHORS (not Linnaeus).

Aëdon megarhyncha SHARPE, Hand-List Gen. and Spec. Birds, IV, 1903, p. 153.

One adult female, from Mount Kilimanjaro, at 5,000 feet, November 23, 1889. "Iris brown; feet dark brownish flesh color. Length 178 mm."

Dr. C. W. Richmond has called the writer's attention to the fact that the generic name *Aëdon* Forster,^a recently employed for this group, is posterior to *Luscinia* Forster,^b and the latter should therefore be adopted—a return to the name so much used for the group, and a fortunate circumstance if change must be made in this much-changed genus.

CICHLADUSA GUTTATA RUFIPENNIS (Sharpe).

Cichladusa rufipennis SHARPE, Bull. Brit. Orn. Club, XII, 1901, p. 35 (Lamu, British East Africa).

One adult male from Kahé, taken September 5, 1888. In its reduced size (wing 81 mm.) this specimen agrees with Doctor Sharpe's *Cichladusa rufipennis* which is undoubtedly not more than a subspecies of *Cichladusa guttata*, and a form whose characters are apparently so slight that without specimens for comparison a satisfactory determination is necessarily difficult. Possibly, however, all the birds from east and south of Victoria Nyanza ought to be referred to *Cichladusa guttata rufipennis*.

This genus appears to be much more properly placed in the Turridæ, as recently done by Doctor Sharpe,^c than in the Timaliidae, as ordinarily treated by authors, for its tarsi are conspicuously booted.

PRATINCOLA AXILLARIS Shelley.

Pratincola axillaris SHELLEY, Proc. Zool. Soc. Lond., 1884, p. 556 (Mount Kilimanjaro, East Africa).

Twelve specimens, from Mount Kilimanjaro, at 5,000, 8,000, and 10,000 feet. Freshly molted specimens taken in April have much

^a Synopt. Cat. Brit. Birds, 1817, p. 53 (type, *Sylvia luscinia* Forster, not Linnaeus).

^b Idem, p. 14 (type, *Luscinia aëdon* Forster=*Sylvia luscinia* Forster [not Linnaeus])=*Luscinia megarhynchos* Brehm).

^c Hand-List Gen. and Spec. Birds, IV, 1903, p. 166.

wood brown or dull tawny buff on the upper parts, principally on the tips of the feathers; but later in the season, in July or August, this wears off, leaving these parts almost solid black. Some males, probably young of the previous year, have whitish or buffy tips to the feathers of the throat; more brownish wing-quills with more conspicuous pale tawny edgings on tertials and wing-coverts; and a suffusion of buff, more or less strong, on the abdomen. Not so much summer change appears to take place in the streaked upper plumage of the adult female, though one killed December 15, 1889, is almost uniform brownish black above, all but narrow lateral traces of the buffy, brownish, or ochraceous edgings of the feathers having disappeared, and those that remain of these are principally on the back. Immature females quite closely resemble the adults, their chief difference lying in the more blended appearance of the upper parts. One specimen that is evidently an immature male is darker above, including wings, tail, sides of head, and sides of neck, with a black throat somewhat overlaid by pale brown. The wing measurement in adult males of our series ranges from 67 to 74 mm.

In *Pratincola sibilla* from Madagascar the inner webs of the wing-quills have pure white edgings, which increase inwardly until the whole of the inner webs of the secondaries is white, while in *Pratincola axillaris* these edgings are less extensive and pale brown. This affords a ready means of distinguishing the two species, especially in fresh plumage, when the black axillars and under wing-coverts of *Pratincola axillaris* are broadly tipped with white. In size *P. sibilla* is about the same as *P. axillaris*. From *Pratincola salax* of western Africa the present species differs much as it does from *P. sibilla*, and in addition is of larger size, the wing of *P. salax* measuring only about 60 to 65 mm.

PINAROCHROA HYPOSPODIA Shelley.

Pinarochroa hypospodia SHELLEY, Proc. Zool. Soc. Lond., 1885, p. 226, pl. XIII.
(Mount Kilimanjaro, East Africa).

Six specimens from Mount Kilimanjaro, at 10,000, 11,000, and 14,000 feet. Two of these in much worn plumage, taken November 15 and December 14, respectively, differ from two others in freshly molted condition, shot April 15, in the more grayish tint of their brown color, particularly on rump, upper tail-coverts, breast, sides, flanks, and crissum. Two young birds, taken November 15, 1888, in a plumage that appears to be undescribed, contrast with the fresh plumaged adult in being rather lighter, more rufescent above, posteriorly with broad obsolete blackish terminal bars; and somewhat duller below, with obsolete irregular dusky bars and squamate markings.

This is another genus recently removed from the Timaliidae to the Turdidæ by Doctor Sharpe,^a and apparently with good reason, for its affinities are thoroughly turdine.

TARSIGER CUCULLATUS Blyth.

Tarsiger cucullatus BLYTH, Ibis, 1867, p. 16 (Gould, manuscript) ("Africa or India;" undoubtedly the former).

Tarsiger orientalis FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 57 (Pangani, German East Africa).

Five specimens, all taken on Mount Kilimanjaro, at from 7,000 to 10,000 feet altitude.

The *Tarsiger cucullatus* of Blyth,^b although always without question synonymized with *T. stellatus*, is quite certainly identical with the northern bird subsequently by Fischer and Reichenow named *Tarsiger orientalis*,^c as clearly shown by Blyth's description, in which the yellow upper tail-coverts are mentioned.

This genus, by reason of its booted tarsi and other turdine characteristics, seems more at home in the Turdidæ than where usually placed, in the Muscicapidæ.

Family SYLVIIDÆ.

ACROCEPHALUS SCHÆNOBÆNUS (Linnæus).

Motacilla schænobænus LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 184 (Europe; [type locality, Sweden]).

Acrocephalus phragmitis AUTHORS.

One specimen, from Taveta, taken May 1, 1888. "Extremely fat."

The name by which this species is commonly known—*Acrocephalus phragmitis*^d—is much antedated by the Linnean designation above adopted, which, furthermore, rests on a basis quite firm enough to warrant its acceptance.

The determination of the generic name properly applicable to the present species has led incidentally to an examination of the entire group at present comprised under the name *Acrocephalus*, and the results of this investigation may be briefly outlined here. After segregating the species belonging to *Tataræ*, which seems to be a sufficiently well characterized genus, though by a number of authors recently merged with *Acrocephalus*, those that remain in *Acrocephalus* should apparently be divided into at least three generic groups, though by far the greater number of species still are to be ranged under the original name.

^a Hand-List Gen. and Spec. Birds, IV, 1903, p. 173.

^b Ibis, 1867, p. 16.

^c Journ. f. Ornith., 1884, p. 57.

^d *Sylvia phragmitis* Bechstein, Orn. Taschenb. Deutschl., 1803, p. 186.

I. *Acrocephalus*.Subgenus *Acrocephalus*.

- Acrocephalus* NAUMANN, Nat. Land- u. Wass.-Vög. nördl. Deutschl., Nachtr. IV, 1811, p. 199 (type, *Acrocephalus lacustris* Naumann = *Turdus arundinaceus* Linnaeus,^a [= *Sylvia turdoides* Meyer^b]).
- Calamoherpe* BOIE, Isis, 1822, p. 552 (type, *Sylvia turdoides* Meyer = *Turdus arundinaceus* Linnaeus).
- Hydrocopsichus* KAUP, Skizz. Entw.-Gesch. Eur. Thierw., 1829, p. 121 (type, *Sylvia turdoides* Meyer = *Turdus arundinaceus* Linnaeus).
- Arundinaceus* LESSON, Traité d'Orn., 1831, p. 419 (type, *Sylvia turdoides* Meyer = *Turdus arundinaceus* Linnaeus).
- Salicaria* SELBY, Ill. Brit. Orn., I, 1833, pp. 196, 197 (type, *Sylvia turdoides* Meyer = *Turdus arundinaceus* Linnaeus).
- Junco* REICHENBACH, Av. Syst. Nat., 1850, pl. LXI (type, *Turdus arundinaceus* Linnaeus).

Subgenus *Muscipeta*.

- Muscipeta* KOCH, Syst. baier. Zool., 1816, p. 162 (type, *Sylvia phragmitis* Bechstein = *Motacilla schænobænus* Linnaeus^c).
- Calamodus* KAUP, Skizz. Entw.-Gesch. Eur. Thierw., 1829, p. 117 (type, *Sylvia phragmitis* Bechstein = *Motacilla schænobænus* Linnaeus).
- Calamodyta* KAUP, Skizz. Entw.-Gesch. Eur. Thierw., 1829, p. 118 (type, *Sylvia aquatica* Temminck = *Sylvia paludicola* Vieillot).
- Caricicola* BREHM, Isis, 1835, p. 245 (type, *Sylvia paludicola* Vieillot).
- Caricicola* BREHM, Naumannia, 1855, p. 284 (type, *Sylvia phragmitis* Bechstein = *Motacilla schænobænus* Linnaeus).

Bill of moderate length; feet not large; secondaries not lengthened, falling short of primaries by more than the exposed culmen; outermost primary narrow, more or less acuminate, shorter than primary coverts, and less than one-third the second primary; second primary longer than the seventh.

Although at first sight there seems to be a great structural difference among some members of this genus as here constituted, this difference lies wholly in the bill, and even here the gap existing between the rather stout turdine beak of *Acrocephalus stentoreus*, with its curved culmen, and the shorter, more slender bill of *A. schænobænus*, with culmen straight except at the tip, is quite perfectly bridged by *A. arundinaceus* and *A. palustris*, together with their related forms. There is, consequently, no choice but to place all under the name *Acrocephalus*, though two subgenera may with propriety be recognized: *Acrocephalus*, to include the Great Reed Warblers—*A. arundinaceus*

^aSyst. Nat., 10th ed., I, 1758, p. 170.

^bVög. Liv.-und Esthl., 1815, p. 116. There seems to be little or no reason for not accepting the name *arundinaceus* Linnaeus for the bird now commonly called *Acrocephalus turdoides*, since the Linnæan name is of unquestioned pertinency and far earlier date. The species should therefore be known as *Acrocephalus arundinaceus* (Linnaeus).

^cThe type of this genus is ordinarily given as *turdoides* (= *arundinaceus*), but quite certainly in mistake, for the figure of the characteristic bill given by Koch is apparently that of *A. schænobænus*, which is also the first species mentioned.

and its allies; and *Muscipeta*, for *A. schanobannus* and *A. aquaticus*, which represent the extreme differentiation, together with all the other forms, such as *A. palustris* and *A. streperus*, not referable to *Tatare* or to either of the two new genera proposed below.

The current names of two other species of *Acrocephalus* appear to require change. The Aquatic Warbler is at present usually called *Acrocephalus aquaticus* (Temminck);^a but an examination of the work in which this appears at once shows that Temminck here does not propose a new name, but merely refers his bird to the *Motacilla aquatica* of Gmelin.^b Therefore if the term *aquatica* be used at all for this warbler it must be credited to Gmelin; but, since Gmelin's description is so very doubtfully identifiable, it is probably best to leave it altogether out of consideration. Following this course, and taking up the first untainted name, the designation of this bird becomes *Acrocephalus paludicola* Vieillot.^c

The name of the bird now known as *Acrocephalus macrorhynchus* Hume,^d is rendered untenable by reason of *Calamoherpe macrorhyncha* von Müller,^e a synonym of *Acrocephalus stentoreus*, so long as the species is retained in the genus *Acrocephalus*, and since this appears to be its proper position it may be called

Acrocephalus orinus, new name.

There seems to be no doubt of the subspecific relationship of *Acrocephalus arundinaceus orientalis* (Temminck and Schlegel) with *Acrocephalus arundinaceus* (Linnaeus), since there is perfect intergradation between the two; but *Acrocephalus stentoreus* (Hemprich and Ehrenberg) appears on the other hand to be a separate species, for aside from other differences of proportion, that of the primaries is, in a large series of specimens, constantly distinctive.

The species of this genus are as follows:

(Subgenus *Acrocephalus*.)

Acrocephalus inexpectatus Berezowski and Bianchi.

Acrocephalus stentoreus (Hemprich and Ehrenberg).

Acrocephalus arundinaceus arundinaceus (Linnaeus).

(Subgenus *Muscipeta*.)

Acrocephalus palustris (Bechstein).

Acrocephalus streperus (Vieillot).

Acrocephalus obsoletus (Heuglin).

Acrocephalus arundinaceus orientalis (Temminck and Schlegel).

Acrocephalus dumetorum dumetorum Blyth.

^a *Sylvia aquatica* Temminck, Man. d'Orn., 1815, p. 131.

^b Syst. Nat., I, ii, 1788, p. 953.

^c *Sylvia paludicola* Vieillot, Nouv. Dict. d'Hist. Nat., XI, 1817, p. 202 (Lorraine, Germany).

^d *Phyllopneuste macrorhyncha* Hume, Ibis, 1869, p. 357 (Rampur, Sutlej Valley, Himalaya Mountains, northwestern India).

^e *Calamoherpe macrorhyncha* von Müller, Beitr. Ornith. Africae, 1853, pl. ix (Fua, Lower Egypt).

Acrocephalus dumetorum affinis Zarudny.
Acrocephalus orinus Oberholser.
Acrocephalus sorgophilus (Swinhoe).
Acrocephalus paludicola (Vieillot).
Acrocephalus schænobæus (Linnaeus).

2. *Tatare*.

Tatare LESSON, *Traité d'Orn.*, 1831, p. 317 (type, *Tatare otaitensis* Lesson = *Sitta caffa* Sparrman [= *Turdus longirostris* Gmelin]).
Eparietes REICHENBACH, *Av. Syst. Nat.*, 1850, pl. LVII (type, *Sylvia syrinx* Kittlitz).

Bill long; feet not proportionately large; secondaries lengthened, falling short of primaries by less than the exposed culmen; outermost primary narrow, more or less acuminate, shorter than primary coverts, and less than one-third the second primary; second primary not longer than the seventh.

The long bill, the relatively short second primary, together with the long secondaries reaching to within the length of the culmen of the tips of the primaries, separate this group sufficiently well from *Acrocephalus*. Among the species to be included here is *Tatare familiaris* Rothschild^a from Laysan Island, Pacific Ocean.

The bird commonly known as *Tatare longirostris* (Gmelin)^b should be called *Tatare caffer* (Sparrman),^c for the latter name undoubtedly applies to the same bird, as well shown by Sundevall,^d and is of earlier date.

The species of *Tatare* are:

Tatare celebensis (Heinroth).
Tatare gouldi (Dubois).
Tatare anstralis (Gould).
Tatare cerrinus (De Vis).
Tatare caffer (Sparrman).
Tatare mendanæ (Tristram).
Tatare pistoi (Tristram).
Tatare syrinx (Kittlitz).
Tatare rehsei (Finsch).
Tatare luscinia Quoy and Gaimard.
Tatare vaughani (Sharpe).
Tatare quinnoctialis (Latham).
Tatare familiaris Rothschild.

3. *Notiocyclus*,^e new genus.

Type.—*Sylvia bœticata* Vieillot.

Bill long; feet large, with long claws, particularly on middle and

^a *Tatare familiaris* Rothschild, *Ann. and Mag. Nat. Hist.*, 6th ser., X, 1892, p. 109.

^b *Turdus longirostris* Gmelin, *Syst. Nat.*, I, ii, 1788, p. 823 (Eimeo and York Islands).

^c *Sitta caffa* Sparrman, *Mus. Carlson.*, I, 1786, pl. iv (no locality given; probably from the Society Islands).

^d *Krit. om Sparrman's Mus. Carlson.*, 1857, p. 4.

^e *νότιος*, meridianus; *κύκλις*, *turdus*.

hind toes; secondaries long, falling short of primaries by less than the exposed culmen; outermost primary broad, not acuminate, much longer than primary coverts and about one-half the length of the second primary; second primary not longer than the seventh.

The type and apparently sole species of this genus, *Notiocybela baticata* (Vieillot), differs so greatly from typical members of the genus *Acrocephalus* that its generic separation seems desirable, if indeed not inevitable. Its principal points of structural distinction from that group are its very long, broad first primary, long secondaries, long bill, large feet with long claws, and more rounded wing, the second primary about equal to the seventh, or even shorter. In some of these characters *Notiocybela* agrees with *Tatara*, but may be distinguished by its long, broad first primary, relatively large feet, with long middle and hind claws.

4. *Anteliocybela*,^a new genus.

Type.—*Acrocephalus bistrigiceps* Swinhoe.

Bill short, feet rather slender; secondaries falling short of primary tips by more than the length of exposed culmen; outermost primary rather narrow, somewhat acuminate, longer than primary coverts, though less than one-third the length of the second primary; second primary not longer than the seventh, usually about equal.

This group differs from *Acrocephalus* chiefly in its longer first primary, which decidedly exceeds the primary coverts; in its relatively shorter second primary; and in its shorter bill, though in this respect it agrees with some forms of the subgenus *Muscipeta*. In *Acrocephalus (Muscipeta) dumetorum* birds of the year sometimes appear to have the first primary slightly longer than the primary coverts, which is probably due to the imperfect development of the latter, and should not be held to invalidate the generic distinction above set forth, since adults have the first primary always shorter than the primary coverts. From *Tatara* the present group differs principally by reason of its shorter secondaries, comparatively longer first primary, and shorter bill; from *Notiocybela* in its less lengthened secondaries, shorter, more acuminate first primary, more abbreviated bill, and much more slender feet.

Apparently the only species to be placed in this genus are:

Anteliocybela bistrigiceps (Swinhoe).

Anteliocybela agricola (Jerdon).

CISTICOLA HUNTERI Shelley.

Cisticola hunteri SHELLEY, Proc. Zool. Soc. Lond., 1889, p. 364 (Mount Kilimanjaro, East Africa).

One specimen from Mount Kilimanjaro, at 10,000 feet, April 15, 1888. "Abundant in low bushes at 10,000 feet."

^a ἀντιήλιος, orientalis; κίχλη, turdus.

CISTICOLA PRINIOIDES Neumann.

Cisticola prinioides NEUMANN, Journ. f. Ornith., 1900, p. 304 (Mau Mountain, British East Africa).

Six specimens, from Mount Kilimanjaro, at 5,000, 6,000, and 8,000 feet, April 3 to 11, 1888. Some of them have not entirely completed the molt. "Abundant in low bushes from 4,000 to 8,000 feet."

These examples exhibit considerable purely individual difference in the streaking on the back, this being in some almost obsolete, in others very broad and conspicuous. Young birds are darker, duller, more uniform on the lower surface, with a heavier wash of ochraceous; also rather darker and duller on the upper parts, with less contrast between pileum and back.

This species differs from its ally *Cisticola hunteri*^a in its lighter, much more rufescent upper surface, including wings and tail, the pileum being dull rufous in conspicuous contrast to the other upper parts; less blackish (more brownish) streaks on the back; and decidedly paler lower surface, the median portion lighter than the rest and dull yellowish white. Both *C. hunteri* and *C. prinioides*, with the intermediate *Cisticola neumanni*,^b seem to be closely related, and differ so much from *Cisticola subruficapilla* in their deeply colored lores and orbital region, as well as lack of light superciliary, not to mention their darker lower surface, together with much duller upper parts, that they should not be easily confused with the last-mentioned species. This record of *Cisticola prinioides* is apparently the first for Mount Kilimanjaro, and is, furthermore, a considerable extension of range. It appears to take the place of *Cisticola hunteri* on the lower slopes of the mountain, at least up to 8,000 feet, which fact taken together with the lack of intermediate specimens indicates that *C. prinioides* is a distinct species, not, as Mr. Hartert has suggested,^c a subspecies of *C. hunteri*.

CISTICOLA ERYTHROPS (Hartlaub).

Drymoea erythrops HARTLAUB, Orn. Westafr., 1857, p. 58 (Calabar, Southern Nigeria, Western Africa).

Two adult males, from Maranu, Mount Kilimanjaro, 5,000 feet, taken April 3 and 22, respectively. "Iris light yellowish brown; feet white."

^a Proc. Zool. Soc. Lond., 1889, p. 364.

^b Hartert, Bull. Brit. Orn. Club, XII, 1901, p. 13 (Mount Kenia, British East Africa).

^c Bull. Brit. Orn. Club, XII, 1901, p. 13.

CISTICOLA LUGUBRIS (Rüppell).

Sylvia (Cisticola) lugubris RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 111 (Gondar, Abyssinia).

One adult male, from Taveta, April 29, 1888.

CISTICOLA CHINIANA (Smith).

Drymoica chiniana SMITH, Ill. Zool. S. Afr., 1843, pl. LXXIX (North of Kurri-chaine, Bechuana Land, South Africa).

One adult specimen, from Kahé, south of Mount Kilimanjaro, September 5, 1888. This large edition of *Cisticola subruficapilla* is sometimes with difficulty to be distinguished from the latter, especially as both appear to occur in the same localities. More light on their relationships is needed. The original spelling of the specific name is not *cheniana*, as often written, but *chiniana*.^a

BRADYPTERUS CINNAMOMEUS SALVADORII (Neumann).

Bradypterus salvadorii NEUMANN, Journ. f. Ornith., 1900, p. 304 (Mount Gurui, German East Africa).

One molting female, from Mount Kilimanjaro, at 10,000 feet, April 16, 1888. Without specimens for comparison this example appears to agree with the characters given by Mr. Neumann for the southern form of *Bradypterus cinnamomeus* recently described by him.^b

BRADYPTERUS BARRATTI Sharpe.

Bradypterus barratti SHARPE, Ibis, 1876, p. 53 (Pilgrim's Rest, Lydenburg District, Transvaal).

Bradypterus rufolavidus REICHENOW and NEUMANN, Ornith. Monatsber., 1895, p. 75 (Mount Kilimanjaro, East Africa).

Four specimens, from Maranu, Mount Kilimanjaro, 6,000 feet. The adult male agrees very closely with the original description of the species, as does also the adult female, though the latter is slightly paler above than the male, rather darker, more rufescent across the breast, less broadly and therefore less conspicuously streaked on the jugulum. A male in juvenal plumage, taken April 4, 1888, is like the adult above, but is darker, duller below, the throat and breast being grayish olive green streaked with yellowish, while the entire lower surface, superciliary stripe, sides of head and neck are strongly suffused with yellowish. A young female, secured April 3, 1888, is very similar but somewhat paler throughout, with less olivaceous on throat and breast. "Abundant in any low bushes, and very restless, continually uttering a short, sharp 'chirrup.'"

^aSmith, Ill. Zool. S. Afr., 1843, pl. LXXIX.

^bJourn. f. Ornith., 1900, p. 304.

This species appears not to have been recorded from Mount Kilimanjaro under the name *Bradypterus barratti*, but a careful examination of the description of *Bradypterus rufiflavus* Reichenow and Neumann,^a from Mount Kilimanjaro, seem to leave little doubt that the latter is but the juvenal plumage of *B. barratti* described above. The range of *B. barratti* is thus extended from Natal and the Transvaal to Mount Kilimanjaro.

■
CALAMONASTES SIMPLEX (Cabanis).

Thamnobia simplex CABANIS, Journ. f. Ornith., 1878, pp. 205, 221 (Ndi, Teita, British East Africa).

One adult male, from Taveta, August 15, 1888.

APALIS THESECLA, new species.

Chars. sp.—Resembling *Apalis griseiceps*, but occiput and cervix brown without a slaty tinge; back, rump, together with edgings of upper wing-coverts and wing-quills, slate color with but a slight wash of olive green; sides of breast brown with scarcely any olive green; lining of wing pure white; abdomen white, with only a faint tinge of yellow; four outer tail-feathers tipped with white.

Description.—Type, adult male, Cat. No. 118074, U.S.N.M.; Mount Kilimanjaro, East Africa, 6,000 feet, August 4, 1888; Dr. W. L. Abbott. Whole head and cervix broccoli brown, paler on forehead, cheeks, and auriculars; back, rump, and upper tail-coverts slate color with a wash of olive green, this most conspicuous on the middle of the back; tail blackish slate color, the central feathers margined with lighter, the two outer pairs with their terminal half white, the next pair with the terminal third of the inner vane white, the fourth pair with white tips; wing-quills and superior coverts sepia brown, all edged exteriorly with slightly greenish slate color, the quills with paler brown inner margins; chin, throat, and breast white, with a black band across the jugulum; sides of breast grayish brown, with a very slight wash of olive green; remainder of under surface yellowish white, the flanks tinged with ashy; lining of wing white; thighs pale brown. Length of wing, 53; tail, 50; exposed culmen, 11; tarsus, 20.5; middle toe, 11.5 mm.

Doctor Abbott obtained only the single specimen above described, but its differences from *Apalis griseiceps*,^b with which alone it needs comparison, are so marked, and so improbably those of either sex, age, or season, that it appears to represent a species hitherto undescribed. In *Apalis griseiceps*, which was also first discovered on Mount

^a Ornith. Monatsber., 1895, p. 75. See also Neumann, Journ. f. Ornith., 1900, p. 305.

^b Reichenow and Neumann, Ornith. Monatsber., 1895, p. 75.

Kilimanjaro, though since recorded from the Uluguru Mountains, German East Africa, southwest of Zanzibar,^a the occiput and cervix have a noticeably slaty shade, in contrast to the clear brown of crown and forehead; the back, sides of breast, and edgings of wing-quills and wing-coverts are almost clear olive green; the lining of the wing is distinctly yellowish; there are only three outer tail-feathers tipped with white; the abdomen is much deeper yellow than in *Apalis thescela*; and the thighs are much darker brown, with a considerable admixture of yellowish olive green, which is almost entirely absent in this new species. There seems to be little, if any, difference in size between *A. griseiceps* and *A. thescela*. The type of the latter, as well as the specimens of *A. griseiceps* obtained by Doctor Abbott, were taken at about the same season, and are in fresh perfect plumage, excellent for purposes of comparison. The original examples of *A. griseiceps* came from an altitude of about 10,000 feet, and it seems probable that from what is now known of its distribution the species does not occur much lower down than this, its place on the lower slopes of the mountain being taken by *Apalis thescela*.

APALIS GRISEICEPS Reichenow and Neumann.

Apalis griseiceps REICHENOW and NEUMANN, Ornith. Monatsber., 1895, p. 75 (Mount Kilimanjaro, East Africa).

Two specimens from Mount Kilimanjaro: one, a male, taken July 31, 1888, at 10,000 feet; the other, with sex undetermined, obtained at 9,000 feet, July 30, 1888. The latter seems to be adult, and in most respects is just like the other, but has a rather paler head and only a narrow, incomplete, black jugular band. It appears thus to be in immature plumage, but if so is hardly a bird of the year. Can it be an adult female?

EUPRINODES GOLZI Fischer and Reichenow.

Euprinodes golzi FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 182 (Great Aruscha, German East Africa).

One adult from Kahé, south of Mount Kilimanjaro, September 7, 1888. "Iris light brown." This example is marked female, though possessing the small black breast spot which Doctor Reichenow states is found only in the male.^b So far as may be determined from descriptions Doctor Abbott's specimen is quite different from *Euprinodes flavocinctus*^c from Ukambani and agrees perfectly with *E. golzi*, which seems to take the place of *E. flavocinctus* in Masai Land. The back and rump are clear yellowish olive green; the head slate gray,

^a Neumann, Journ. f. Ornith., 1900, p. 307.

^b Vogel Deutsch Ost-Afr., 1894, p. 224.

^c Sharpe, Journ. f. Ornith., 1882, p. 346 (Athi River, Ukambani, British East Africa).

with but a slight wash of greenish; lores dull grayish white; orbital region dull grayish.

There seems to be not sufficient reason for merging the genus *Euprinodes* with *Apalis*, as has been done by Doctor Reichenow,^a and more recently by Mr. Neumann,^b for the relatively much smaller size of the feet in the former is a satisfactory distinction in so far at least as it concerns the species we have examined.

SYLVIETTA MICRURA (Rüppell).

Troglodytes micrurus RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 109, pl. XII, fig. 2 (Kordofan, Sennaar, and all Abyssinia).

One adult female, from the plains of Taveta, August 13, 1888. This is true *S. micrura*, with white chin, cheeks, and superciliary stripe.

It is probably worth while to call attention to the fact that the original and therefore proper spelling of the genus to which this species belongs is *Sylvietta*,^c not *Sylviella*, as commonly written, the latter being simply an emended form.

SYLVIETTA WHYTII JACKSONI (Sharpe).

Sylviella jacksoni SHARPE, Bull. Brit. Orn. Club, VII, 1897, p. vii (Kamassia, British East Africa).

One molting female, from Taveta, July 6, 1888.

Mr. Grant synonymized^d this form with *Sylvietta whytii*,^e but Doctor Sharpe, with additional material at his disposal, has since asserted its distinctness.^f It seems to be larger and darker than *S. whytii*,^g and, though closely allied, is doubtless separable as a subspecies, the northern representative of true *Sylvietta whytii* from Nyassa Land.

The measurements of Doctor Abbott's specimen are: Wing, 57; tail, 26; exposed culmen, 10.5; tarsus, 18; middle toe, 10.5 mm.

EREMOMELA SCOTOPS Sundevall.

Eremomela scotops SUNDEVALL, Öfv. K. Vet.-Akad. Förh. Stockholm, 1850, p. 103 ("Caffraria superiore," 25° S. Lat.).

One adult, from Kidudwe, 90 miles inland from Zanzibar, December, 1887. This agrees perfectly with descriptions of specimens from

^a Vögel Deutsch Ost-Afr., 1894, p. 224.

^b Journ. f. Ornith., 1900, p. 306.

^c Lafresnaye, Rev. Zool., 1839, p. 258.

^d Ibis, 1900, p. 155.

^e *Sylviella whytii* Shelley, Ibis, 1894, p. 13 (Zomba, Nyassa Land).

^f Ibis, 1901, p. 70.

^g In the original description of *Sylvietta whytii* (Ibis, 1894, p. 13) the length of wing is given as 3.15 inches, which is manifestly an error, probably for 2.15, as the wing of *Sylvietta rufescens*, a larger species, is only about 2.50 inches.

Transvaal and Mashona Land; and furthermore Dr. R. B. Sharpe, to whom it was submitted for examination, professed his inability to separate it from South African examples. The species has previously not been recorded from north of Mashona Land, so its range is hereby greatly extended.

CAMAROPTERA BREVICAUDATA (Cretzschmar).

Sylvia brevicaudata CRETZSCHMAR, in Rüppell's Atlas Reis. Nördl. Afr., Vög., 1826, p. 53, pl. xxxvb (Kordofan, northern Africa).

Six specimens, from Taveta and Mount Kilimanjaro, at 5,000 feet. "Iris light brown." Immature birds, taken in May, are more brownish above than the adults, and are strongly tinged with ochraceous across the breast. One still younger is olive brown above except on rump and scapulars—the latter being olive green, the former slate gray—and has some light yellow on abdomen, breast, chin, throat, and sides of head. In all these examples, adult as well as young, but more conspicuous in the latter, there are on the breast, and sometimes on upper abdomen and sides as well, obsolete pale grayish vermiculations.

PRINIA MISTACEA Rüppell.

Prinia mistacea RÜPPELL, Neue Wirb. Faun. Abyss., Vögel, 1835, p. 110 (Gondar, Abyssinia).

Two males, from Taveta, taken March 23, 1888. One is in the lighter, more rufescent plumage of the immature.

Family MUSCICAPIDÆ.

MELÆNORNIS ATER TROPICALIS (Cabanis).

Melanopepla tropicalis CABANIS, Journ. f. Ornith., 1884, p. 241 (Ukamba, British East Africa).

One example, from Taveta, August 18, 1888. This is a female in the black plumage, but small tips of ochraceous on the greater wing-coverts and the innermost secondaries, together with a few ochraceous-barred feathers on the breast and abdomen, indicate its immaturity.

MUSCICAPA STRIATA NEUMANNI (Poche).

Muscicapa grisola sibirica NEUMANN (not Gmelin), Journ. f. Ornith., 1900, p. 259 (Loita Mountain, northwestern Masai Land, German East Africa, winter).

Muscicapa grisola neumanni POCHÉ, Ornith. Monatsber., 1904, p. 26 (nom. emend.).

Two specimens: one from "East Africa," the other from the Useri River near Mount Kilimanjaro, August 30, 1888. Though rather darker than one from the Thian Shan Mountains, central Asia, these two specimens belong without doubt to the apparently recognizable form *sibirica* recently described by Mr. Neumann. Its principal

character is the much paler color of the upper surface; for the less conspicuous streaking of the lower parts, given by Neumann as an additional distinction, appears not to be constant enough to be of value.

Unfortunately Mr. Neumann's term *sibirica* is preoccupied by *Muscicapa sibirica* Gmelin,^a which is now *Hemichelidon sibirica* (Gmelin), and another name is therefore necessary for the central Asian form of *Muscicapa striata* he distinguished. This has been recently supplied by Poche,^b and the bird should accordingly be called *Muscicapa striata neumanni*, as above. The *Muscicapa grisola* of Linnaeus,^c of which this form is a subspecies, must give place to the earlier *Motacilla striata* of Pallas,^d as already pointed out by Dr. C. W. Richmond.^e

ALSEONAX MURINUS MURINUS Fischer and Reichenow.

Alseonax murina FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 54 (Mount Meru, Masai Land, German East Africa).

Four specimens, from Mount Kilimanjaro, at 5,000 and 10,000 feet. Two of these, male and female, taken respectively June 8 and July 23, 1888, are in fresh plumage, and are much more buffy on the lower surface than a worn female obtained April 16, 1888.

The fourth example, secured April 19, 1888, is a male in the unrecorded juvenal plumage, and may be described as follows: Upper parts grayish brown, becoming more rufescent posteriorly, everywhere with hastate spots of buffy or ochraceous, these palest on crown and darkest on upper tail-coverts, least numerous on head, smallest on nape; wings and tail fuscous, the tertials, inner secondaries, median and greater coverts margined with ochraceous buff; lores, eye ring, and extreme forehead ochraceous, much mixed with blackish; sides of head and neck, with entire lower surface, buff, thickly streaked with brownish black, except on lower abdomen and crissum, which are immaculate; lining of wing ochraceous buff mixed with brownish.

CICHLOMYIA,^f new genus.

Chars. gen.—Similar to *Muscicapa* Brisson, but tail longer (about three-fourths of wing); second primary shorter than sixth; four primaries sinuate on their outer webs; spurious primary very much longer than primary coverts.

Type.—*Butalis caerulea* Hartlaub.

By most authors this genus has been included, at least partly, in

^a Syst. Nat., I, ii, 1788, p. 936.

^b Ornith. Monatsber., 1904, p. 26.

^c Syst. Nat., 12th ed., I, 1766, p. 328.

^d In Vroeg's Catal., 1764, Adumbrat., p. 3.

^e Smithson. Quart., II, 1905, p. 345.

^f *Κίχλη*, *turdus*; *μυῖα*, *musca*.

Muscicapa, and by Doctor Reichenow in *Alseonax*,^a but it is sufficiently different from either to have a name of its own.

From *Alseonax* it may be distinguished by its much narrower, more compressed bill, very similar to *Dioptrornis*, the culmen more arched, more curved, and the terminal portion more strongly unguulate; also the rictal bristles are usually less well developed. The segregation of this group makes necessary a rearrangement of some of the closely allied genera, and accordingly there will be found below a statement of the characters that distinguish these, together with enumeration of the species that appear to belong to each.

1. *Muscicapa*.

Muscicapa BRISSON, Ornith., II, 1760, p. 357 (type, *Muscicapa grisola* Linnæus=*Motacilla striata* Pallas).

Butalis BOIE, Isis, 1826, p. 973 (type, *Muscicapa grisola* Linnæus=*Motacilla striata* Pallas).

Bill somewhat depressed, the culmen almost straight except at the decurved tip; rictal bristles moderately developed; exposed culmen about equal to middle toe without claw; tail about two-thirds the length of wing; wing much pointed, the second primary longer than the fifth; three primaries sinuate on their outer webs; spurious primary about equal to primary coverts.

Typical *Muscicapa* as above defined becomes restricted to the following forms:

Muscicapa striata striata (Pallas).

Muscicapa striata neumanni (Poche).

? *Muscicapa finschi* Bocage.

2. *Ficedula*.

Ficedula BRISSON, Ornith., III, 1760, p. 369 (type, *Motacilla ficedula* Linnæus^b).

Hedymela SUNDEVAL, Öfv. K. Vet. Ak. Förh. Stockholm, 1846 (1847), p. 225 (type, *Motacilla atricapilla* Linnæus=*Motacilla ficedula* Linnæus).

Bill slightly parine, only a little depressed, the culmen almost straight except at the decurved tip; rictal bristles weak; exposed culmen decidedly less than middle toe without claw; tail about two-thirds the length of wing; wing much pointed, the second primary shorter than the fifth, but longer than the sixth; three primaries sinuate on outer webs; outermost primary barely if at all longer than primary coverts.

This genus, commonly merged with *Muscicapa*, has been recently and very justly separated by Doctor Sharpe under the antedated name *Hedymela*.^c Its forms are:

Ficedula ficedula ficedula (Linnæus).

Ficedula ficedula speculigera (Bonaparte).

Ficedula semitorquata (Homeyer).

Ficedula albicollis (Temminck) (= *collaris* Bechstein^d).

^a Vögel Africas, II, 1903, pp. 452-460.

^b *Motacilla ficedula* Linnæus, Syst. Nat., 10th ed., I, 1758, p. 185. This is undoubtedly the same as *Motacilla atricapilla* Linnæus, Syst. Nat., 10th ed., I, 1758, p. 187, and as it stands first should be adopted.

^c Hand-List Gen. and Spec. Birds, III, 1901, p. 213.

^d See Oberholser, Smithsonian. Quart., III, 1905, p. 65.

3. *Arizelomyia*,^a new genus.

Type.—*Muscicapa latirostris* Raffles.

Bill depressed, the culmen nearly straight except at the ungulate tip; rictal bristles moderately developed; exposed culmen equal to middle toe without claw; tail about three-fourths of wing; wing pointed, the second primary longer than the sixth; three primaries sinuate on their outer webs; first (outermost) primary decidedly (at least 5 mm.) longer than primary coverts.

This genus differs from *Alseonax*, with which it has been commonly associated, in the following particulars: Bill narrower; rictal bristles usually not so well developed; only three primaries sinuate on their outer vanes; wing more pointed, the second primary longer than the sixth. From *Muscicapa* it may be distinguished by its relatively longer tail, long outermost primary, and broader bill.

The type species, *Arizelomyia latirostris* (Raffles), is the only one now certainly referable to this genus, though *Alseonax muttui* (Layard) may prove to belong here; *Muscicapa ruficauda* of Swainson, which has been examined, is not congeneric with *Arizelomyia latirostris*.

4. *Alseonax*.

Alseonax CABANIS, Mus. Hein, I, 1850, p. 52 (type, *Butalis adusta* Boie).

Bill broad, much depressed, the culmen almost straight except at the decurved tip; rictal bristles strongly developed; exposed culmen about equal to middle toe without claw; tail about three-fourths the length of wing; wing rounded, the second primary about equal to the seventh; four primaries sinuate on their outer webs; outermost primary decidedly (more than 5 mm.) longer than primary coverts.

The following species are to be referred to this genus:

Alseonax adustus (Boie).

Alseonax subadustus Shelley.

Alseonax angolensis Reichenow.

Alseonax murinus murinus Fischer and Reichenow.

Alseonax murinus pumilus (Reichenow).

Alseonax murinus djambjaniensis Neumann.^b

Alseonax murinus obscurus (Sjöstedt).

Alseonax murinus poensis (Alexander).

Alseonax gambagæ Alexander.

Alseonax comitatus (Cassin).^c

Alseonax epulatus epulatus (Cassin).

Alseonax epulatus fantisiensis (Sharpe).

Alseonax infulatus (Hartlaub).

Alseonax aquaticus (Heuglin).

5. *Cichlomyia*.

Cichlomyia OBERHOLSER, p. 908 (type, *Butalis cærulescens* Hartlaub).

Bill somewhat compressed, rather vireonine, the culmen more or less curved throughout most of its length, the tip strongly ungulate; rictal bristles moderately developed; exposed culmen about equal to middle toe without claw; tail about three-fourths the length of wing;

^a ἀρίζηνλος, evidens; μυῖα, musca.

^b Journ. f. Ornith., 1905, p. 206.

^c An examination of Cassin's type shows this species to be a true *Alseonax*, though placed in *Pedilorhynchus* by Doctor Reichenow (Vögel Africas, II, 1903, p. 461).

wing pointed, second primary about equal to the seventh; four primaries sinuate on outer webs; outermost primary much (more than 5 mm.) longer than primary coverts.

The species that appear to belong to this genus are as follows:

Cichlomyia cærulescens cærulescens (Hartlaub).

Cichlomyia cærulescens cinerascens (Sharpe).

Cichlomyia toruensis (Hartert).

Cichlomyia lugens (Hartlaub).

Cichlomyia modesta (Hartlaub).

Cichlomyia minima (Heuglin).

6. *Dioptrornis*.

Dioptrornis FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 53 (type, *Dioptrornis fischeri* Reichenow).

Bill somewhat compressed, rather vireonine, the culmen more or less curved throughout most of its length, the tip strongly unguulate; rictal bristles strongly developed; exposed culmen shorter than middle toe without claw; tail long, about four-fifths the length of the wing; wing rounded, the second primary shorter than the ninth; four primaries sinuate on their outer webs; outermost primary more than 5 mm. longer than primary coverts.

This genus appears to be more closely allied to *Cichlomyia* than to any of the others above diagnosed, but is readily distinguishable from that group. The following species are current:

Dioptrornis brunneus Cabanis.

Dioptrornis fischeri Reichenow.

Dioptrornis nyikensis (Shelley).

Dioptrornis chokolatinus (Rüppell).

Dioptrornis reichenowi (Neumann).

The following key to the six genera of *Muscicapidae* above involved may be of some assistance in identification as well as in further comparison of characters:

- A. Three primaries sinuate on outer webs; second primary longer than sixth.
 - a. Tail longer—about three-fourths of wing; bill broader; first primary exceeding primary coverts by at least 5 mm *Arizelomyia*
 - a'. Tail shorter—about two-thirds of wing; bill more narrow; first primary exceeding primary coverts by less than 5 mm.
 - b. Bill not shorter than middle toe without claw; rictal bristles well developed; second primary longer than fifth *Muscicapa*
 - b'. Bill shorter than middle toe without claw; rictal bristles weak; second primary shorter than fifth *Ficedula*
- B. Four primaries sinuate on outer webs; second primary shorter than sixth.
 - a. Bill broad and flat *Alseonax*
 - a'. Bill narrow and arched.
 - b. Rictal bristles reaching beyond middle of bill; second primary shorter than ninth; bill shorter than middle toe without claw... *Dioptrornis*
 - b'. Rictal bristles not reaching to middle of bill; second primary longer than eighth; bill about equal to middle toe without claw... *Cichlomyia*

CICHLOMYIA CÆRULESCENS (Hartlaub).

Butalis cærulescens HARTLAUB, Ibis, 1865, p. 267 (Natal).

Two adults, from Taveta, March 23 and July 22, 1888.

DIOPTORNIS FISCHERI Reichenow.

Dioptrornis fischeri REICHENOW, Journ. f. Ornith., 1884, p. 53 (Mount Meru, Masai Land, German East Africa).

Two adult females from Mount Kilimanjaro, at 5,000 feet, October 18 and November 23, 1889. "Iris dark brown."

CHLOROPETA NATALENSIS SIMILIS (Richmond).

Chloropeta similis RICHMOND, Auk, XIV, 1897, p. 163 (Mount Kilimanjaro, East Africa).

Chloropeta kenya SHARPE, Bull. Brit. Orn. Club, XII, 1901, p. 35 (Mount Kenia, British East Africa).

Four specimens, from Mount Kilimanjaro, at 8,000 and 10,000 feet, June 10 and July 29, 1888.

There can be little doubt of the identity of Doctor Richmond's *Chloropeta similis* and Doctor Sharpe's *Chloropeta kenya*, for the original specimens of the former differ from *Chloropeta natalensis natalensis* exactly as mentioned for the latter by Doctor Sharpe,^a as well as in some other particulars which were not noted by him. Doctor Sharpe apparently overlooked the description of *Chloropeta similis*, and Doctor Reichenow, curiously enough, appears to have done the same, since this name is not to be found in his recent treatment of the genus.^b From *Chloropeta natalensis natalensis* this northern form *C. n. similis* may readily be distinguished by its more greenish (less yellowish), olive-green upper parts, this particularly evident on the back and upper tail-coverts; darker auricular and orbital regions, these being nearly like the crown; more greenish, less buffy yellow of lower surface; more olivaceous thighs, flanks, sides of neck and of body. Mount Kenia and Mount Kilimanjaro seem to be the only localities at which this race of *natalensis* has yet been discovered.

BATIS SENEGALENSIS ORIENTALIS (Heuglin).

Platystira orientalis HEUGLIN, Ornith. Nordost-Afr., I, 1871, p. 449 (Abyssinia).

One adult female, from Taveta, August 17, 1888. In this example the white of the cervix and the upper part of the sides of the neck is strongly tinged with ochraceous, a vergence toward *Batis senegalensis*, from which form *orientalis* appears to be but subspecifically separable.

BATIS MIXTA (Shelley).

Pachyprora mixta SHELLEY, Proc. Zool. Soc. Lond., 1889, p. 359 (Mount Kilimanjaro, 6,000-7,000 feet, East Africa).

Three adults—two males and a female—from Mount Kilimanjaro, at 6,000 feet, collected June 12, August 11, and August 8, 1888.

^a Bull. Brit. Orn. Club, XII, 1901, p. 35.

^b Vögel Africas, II, 1903, pp. 464-466.

respectively. In all these specimens, the female included, the upper tail-coverts are glossy black, not gray, as given by Captain Shelley;^a and the rump has large concealed spots of white. In one of the males the white nuchal spot is very indistinct. In the female the rufous of the breast is quite deep in color, though overlaid to some extent by white unworn tips of the feathers, and is much darker than that of the throat, from which it is separated medially by a pure white spot some 10 millimeters wide, both of which are characters that look toward *Batis dimorpha* Shelley,^b and, together with what Doctor Reichenow has pointed out,^c indicate that *B. dimorpha*, if really distinct from *B. mixta*, is but a subspecies, and should stand as *Batis mixta dimorpha*.

It will be noted by reference to the above-given dates of collection that Doctor Abbott's specimens of *Batis mixta* were the first of the species taken; and, furthermore, with the exception of the two obtained by Mr. H. C. V. Hunter, from which the species was described by Captain Shelley,^a they seem to be the only ones thus far known. Our three specimens exhibit the following measurements:

Sex.	Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
			mm.	mm.	mm.	mm.	mm.
Male	Mount Kilimanjaro, East Africa.	June 12, 1888	62	36	12	16	10
Male	do	Aug. 11, 1888	62	37.5	11.5	17.5	10
Female	do	Aug. 8, 1888	63	36	12	17.5	10

PLATYSTEIRA CRYPTOLEUCA, new species.

Chars. sp..—Like *Platysteira peltata*, but cervix with a large concealed patch of pure white, and the feathers of the rump entirely without white markings.

Description..—Type, adult male, Cat. No. 118133, U.S.N.M.; Usuri River, plains of Mount Kilimanjaro, August 29, 1888; Dr. W. L. Abbott. Pileum, cervix, and upper tail-coverts black with a steel-green gloss; the cervix with bases of its feathers pure white, forming a large concealed patch; back and rump greenish slate color with considerable metallic gloss, especially on the former, the latter without either white concealed spots or white tips on the feathers; tail blackish with steel green metallic sheen, the feathers margined externally with grayish and tipped ever so slightly with whitish; wings blackish brown, the lesser and median coverts, together with broad margins of greater coverts and tertials, black with metallic green gloss like the crown,

^a Proc. Zool. Soc. Lond., 1889, p. 359.

^b *Pachyporrora dimorpha* Shelley, Ibis, 1893, p. 18 (Milanji Plateau, Nyassa Land, eastern Africa).

^c Vögel Africas, II, 1903, pp. 478-479.

the primaries and secondaries edged externally with grayish; sides of head and neck, with a broad pectoral band, metallic greenish like the pileum; rest of lower surface white; thighs blackish mixed with white; lining of wing white interiorly, then brown, and finally metallic green along the edge of the wing. Length of wing, 65; tail, 52; exposed culmen, 13; tarsus, 18.5; middle toe, 10 mm.

Two other specimens were obtained by Doctor Abbott: an immature male at Taveta, August 14, 1888; and an immature female at Kahé, south of Mount Kilimanjaro, September 6, 1888. These birds both have a large concealed white nuchal spot, though it is less pronounced than in the adult.

The immature male is mostly brownish slate color, slightly glossy on the upper surface, mixed with metallic greenish or bluish black feathers on head and sides of neck; tail sepia brown, except one metallic greenish middle feather which belongs to the adult stage, the outer webs of rectrices with grayish buff edges; outermost pair of feathers bordered on both webs with buffy white at tip, forming a V-shaped terminal mark; second pair with only inner web white at end; wing-quills fuscous, the feathers edged with dull ochraceous; greater wing-coverts broadly, and primary coverts somewhat, margined and tipped with tawny ochraceous; lesser and middle coverts tawny olive; under wing-coverts partly brown, partly white; axillars white; inner webs of wing-quills broadly edged with buffy white; the metallic greenish black pectoral band is making its appearance and displacing some wood brown feathers which preceded it; throat and chest buffy white, mixed with dusky; rest of lower surface yellowish white.

The immature female is very much like the immature male just described, but lacks the greenish black feathers of pectoral band and head; the lores are mixed with whitish; there is a patch of cinnamon on each side of the breast, which extends to the side of the neck; the wing-quills and greater wing-coverts have paler ochraceous edges, the lesser and middle coverts are wood brown; the tail-feathers are edged with grayish white instead of grayish buff, the outer web of the outermost feather margined with pure white for most of its exposed portion; and the under parts are more purely white. In both of these immature birds the eye wattle is, in the dried skin, ochraceous buff; in the adult male in life it is red, but in the skin yellow, though of much deeper shade than that of the immature.

None of the descriptions of *Platysteira peltata* make any mention of a concealed white spot on the hind neck, and it seems incredible that a character so conspicuous on the slightest disturbance of the overlying feathers should, if present, have so uniformly been overlooked, particularly since the same is carefully noticed in other species. In size *Platysteira cryptoleuca* seems not to differ from *P. peltata*.

TROCHOCERCUS BIVITTATUS Reichenow.

Trochocercus bivittatus REICHENOW, Ornith. Centralblatt, 1879, p. 108 (Muniumi, British East Africa).

Three specimens of this rare species: one adult male from Taveta, July 6, 1888; and two immature males from Mount Kilimanjaro, at 6,000 feet, June 12 and August 8, 1888.

The immature males may be described as follows: Upper parts brownish slate, rather clearer on the upper tail-coverts and the somewhat crested pileum, the latter with a slight metallic gloss; tail-feathers grayish brown with slate-colored outer margins; wings fuscous, the quills with paler outer edges, the lesser coverts slate-color, the tertials and the primary coverts narrowly margined with ochraceous, the greater coverts with broad ochraceous tips that form a conspicuous wing-band; sides of head and neck slate-gray, the auriculars rather brownish, the lores, orbital ring, and cheeks mixed with white; throat, breast, and sides slate gray, the last streaked, the others spotted, with white; abdomen and crissum white; inferior wing-coverts brownish slate with some white; axillars white.

TCHITREA SUAHELICA (Reichenow).

Terpsiphone perspicillata suahelica REICHENOW, Werth. Mittl. Hochl. deutsch Ost-Afr., 1898, p. 275 (East Africa).

Five specimens, from Taveta, and Mount Kilimanjaro at 5,000 feet. All are in the chestnut-backed plumage, and two of the males have fully developed long tail-feathers. Another male is just like these except for a short tail. The two others, one a male, the other not marked for sex, are quite young, and aside from having short tails, differ further in being paler above, the head dull slaty with little metallic sheen and this confined to the top; wings dull brown with rufous but no white edgings; lower parts paler, the throat slate color like the breast, the under tail-coverts more strongly rufescent; sides of head and neck slate color. "Iris (of older males) brown; feet slaty blue; bill light blue, black at tip, light green inside; bare skin around eyes and at angle of mouth light blue."

As Mr. Oscar Neumann has aptly intimated,^a the relationships of *Tchitreia suahelica*, *T. viridis*, and *T. perspicillata* are by no means satisfactorily demonstrated. The first mentioned is apparently a distinct species, as formerly maintained by Neumann,^a but in many characters it is intermediate between *T. perspicillata* and *T. viridis*, on the whole scarcely nearer one than the other. Its more blackish primaries and primary coverts (both of which have white outer edgings), more bluish head, and possession of a white-backed adult plumage point strongly its affinity toward *T. viridis*; while the much paler,

^a Journ. f. Ornith., 1900, p. 228.

more grayish, lower parts, with whitish crissum and under wing-coverts, and metallic color of the throat but little if at all extended back over the breast, are characters shared by *T. perspicillata*. Two birds in white-backed plumage, from Somali Land, collected by Dr. A. Donaldson Smith, are in the United States National Museum, and are clearly referable to *Tchitreia viridis*, or, if Mr. Neumann's recently proposed separation be accepted,^a *Tchitreia viridis ferreti* (Guérin), although from this region we might naturally expect *T. suahelica*.

CRYPTOLOPHA UMBROVIRENS DORCADICHROA (Reichenow and Neumann).

Camaroptera dorcadichroa REICHENOW and NEUMANN, Ornith. Monatsber., 1895, p. 76 (Mount Kilimanjaro, East Africa).

Seven specimens from Mount Kilimanjaro, at altitudes of 6,000, 7,000, and 10,000 feet. "Abundant in the forest zone."

This fine series appears to establish the validity of Doctor Reichenow's *Cryptolopha dorcadichroa*, as distinct from *C. u. mackenziana*, a view already expressed by Dr. Sharpe.^b Despite a considerable individual variation these specimens do not agree well with either the original description^c or the plate^d of *Cryptolopha u. mackenziana*, particularly on the lower surface, but do agree, as they should from geographical considerations, with the description of *C. u. dorcadichroa*,^e barring the single unimportant exception that the lesser wing-coverts are like the others, not of the same color as the back. The six adults—males and females—are very uniform on the upper parts, but differ considerably below. Most of them have the chin and upper throat dull ochraceous buff, mixed to some degree with yellowish; the jugulum rather paler and more grayish; the breast almost like the upper throat; but no two specimens are exactly alike in these respects. One has the whole anterior lower surface almost uniformly pale dull grayish ochraceous mixed with yellowish; another has the chin and upper throat principally dull yellow with a slight wash of ochraceous buff, the breast and jugulum ochraceous buff mingled with yellow. In some examples the central portion of the abdomen is almost pure white, in others strongly tinged with yellow; there is also a very appreciable variation in the shade of the cinnamon brown on flanks and sides; while the crissum ranges in different individuals from almost pure pale yellow to light cinnamon color. Thus *Cryptolopha u. dorcadichroa* differs chiefly from *C. u. mackenziana* in that the fore parts below are as a rule much more yellowish, and the chin with the upper throat dull

^a Journ. f. Ornith., 1905, p. 211.

^b Ibis, 1901, p. 91.

^c Sharpe, Ibis, 1892, p. 153.

^d Ibis, 1901, pl. III, fig. 1.

^e Reichenow and Neumann, Ornith. Monatsber., 1895, p. 76.

ochraceous buff or pale tawny instead of grayish white. An immature bird, a female, is like the adults above, but has the superciliary stripe and the entire lower surface deeply tinged with yellow, the latter being almost uniform, save that the abdomen is rather paler, the flanks and sides cinnamonaceous, the throat and breast somewhat though inconspicuously washed with ochraceous.

Family PARIDÆ.

PARUS THRUPPI BARAKÆ (Jackson).

Parus barakæ JACKSON, Ibis, 1899, p. 639 (Njemps, British East Africa).

One adult female, from the plains east of Mount Kilimanjaro, October 3, 1888. The type, and the example recorded by Neumann^a seem to be the only ones besides this Abbott specimen that have thus far been taken. This last agrees well with the original description, and seems to indicate the validity of *barakæ*, at least as a subspecies.

ANTHOSCOPUS MUSCULUS (Hartlaub).

Aegithalus musculus HARTLAUB, Ornith. Centralblatt, 1882, p. 91 (Lado, Upper White Nile, British Equatorial Africa).

One female, from Taveta, August 18, 1888. This appears to be the southernmost locality for the species and considerably extends its range. The records of Captain Shelley^b and Doctor Sharpe^c for the vicinity of Mount Kilimanjaro were both based on this example.

Family CORVIDÆ.

CORVULTUR ALBICOLLIS (Latham).

Corvus albicollis LATHAM, Ind. Orn., I, 1790, p. 151 (Africa).

Two specimens: an adult female from Maranu, Mount Kilimanjaro, 5,000 feet, April 5, 1888; and a male from Kahé, south of the same mountain, May 8, 1888. "Length of male, 22 inches."

CORVUS SCAPULATUS Daudin.

Corvus scapulatus DAUDIN, Traité d'Orn., II, 1800, p. 232 (type locality, Cape of Good Hope).

Two specimens from Mount Kilimanjaro, at 5,000 feet altitude, December 6, 1889. These appear to be absolutely identical with birds from Madagascar and Aldabra Island.

^aJourn. f. Ornith., 1900, p. 301.

^bBirds of Africa, II, 1900, p. 255.

^cHand-List Gen. and Spec. Birds, IV, 1903, p. 341.

Family ORIOLIDÆ.

ORIOLUS LARVATUS ROLLETI (Salvadori).

Oriolus rolleti SALVADORI, Atti Soc. Ital. Sci. Nat., VII, 1864, p. 161 (White Nile, eastern Africa).

Three males, two of them adult, the other immature, from Taveta, seem to be typical of this form. Dr. Abbott writes that it was taken also on Mount Kilimanjaro, but no specimens were sent from this locality.

The characters separating *Oriolus rolleti* from *O. larvatus* are such that a trinomial best expresses their relationship.

ORIOLUS NOTATUS Peters.

Oriolus notatus PETERS, Journ. f. Ornith., 1868, p. 132 (Tete, Portuguese East Africa).

Two specimens, adult male and female, from Taveta.

ORIOLUS ORIOLUS Linnæus.

Coracias oriolus LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 107 (Europe and Asia).

Two females, from the plains east of Mount Kilimanjaro, taken October 3, 1888. "Iris red."

If Linnæus be taken at 1758, the proper name for the present species is *Oriolus oriolus*, as above given, instead of the current *Oriolus galbula*.^a

Family DICRURIDÆ.

DICRURUS ADSIMILIS DIVARICATUS (Lichtenstein).

Muscicapa divaricata LICHTENSTEIN, Verz. Doubl. Zool. Mus. Berlin, 1823, p. 52 (Senegambia, western Africa).

Two specimens: one from Kidudwe, 90 miles inland from Zanzibar, December, 1887; the other from the plains east of Mount Kilimanjaro, October 6, 1888. "Iris red."

There seem to be absolutely no trenchant structural characters by which the so-called genus *Bhuchanga* can be separated from *Dicrurus*. The chief, if indeed not the only, distinction claimed is the difference in the emargination of the tail; but this is subject to such variation in the different species, and withal presents so many intermediate phases, that its generic value is quite obliterated.

In treating the present species Doctor Reichenow^b recognizes by

^a See Reichenow, Vögel Deutsch Ost-Afr., 1894, p. 168.

^b Vögel Africas, II, 1903, pp. 646-650.

name only a single form, although he admits that there are other recognizable races, and that they occupy definite geographic areas. His reason for refusing them recognition in nomenclature—"... gehen indessen derartig ineinander über"^a—is hardly sufficient, particularly from a modern standpoint! At least three subspecies of *Dicrurus adsimilis* may readily be distinguished, as follows:

1. *Dicrurus adsimilis adsimilis* (Bechstein).

Corvus afer LICHTENSTEIN, Cat. Rer. Nat. Rar. Hamburg, 1793, p. 10 (not Linnaeus) (South Africa).

Corvus adsimilis BECHSTEIN, Latham's Allgem. Uebers. Vögel, II, 1794, p. 362 (South Africa).

Dicrurus musicus VIEILLOT, Nouv. Dict. d'Hist. Nat., IX, 1817, p. 586 (Cape of Good Hope).

Muscicapa emarginata LICHTENSTEIN, Verz. Doubl. Zool. Mus. Berlin, 1823, p. 52 (Caffraria).

Size largest, the wing measuring 133–146 mm.; wing-quills brown or blackish brown, paler on the inner webs.

Cape Colony, north probably to Transvaal and German Southwest Africa.

Doctor Reichenow has used the specific name *afer* of Lichtenstein^b for this species,^c and in this he has been followed by some other authorities; but aside from the fact that *Corvus afer* Lichtenstein^b is preoccupied by *Corvus afer* Linnaeus,^d and thus of course untenable, this name of Lichtenstein's is not, as has apparently been supposed, a new name at all, but as may easily be seen by reference to the original,^e indicates merely a doubtful identification of the specimen in hand with the *Corvus afer* of Linnaeus. All of Lichtenstein's novelties in the "Catalogus" are followed by the word "nobis," but in the present instance he writes only "99 *Corvus afer*? Linn. spec. 12," preferring to use this name with a query instead of describing his bird as new, though he goes on to point out the fact that it does not agree entirely with the species to which he refers it, and is probably undescribed. There are a large number of similar cases in this work, and it is perfectly evident that Lichtenstein did not even intend any of these citations as new names. The proper designation for the species, after *afer* is disposed of, seems to be undoubtedly *Corvus adsimilis* Bechstein,^f which rests upon a firm basis, being adequately described, and furthermore a renaming of Lichtenstein's *Corvus afer*. Doctor Sharpe quotes and uses this name,^f though he cites the wrong page, which mistake may possibly account for the apparent inability of Doctor Reichenow to verify the reference, the latter giving it only on Doctor Sharpe's authority.^g

^a Vögel Africas, II, 1903, p. 647.

^b Cat. Rer. Nat. Rar. Hamburg, 1793, p. 10.

^c Vögel Africas, II, 1903, p. 646.

^d Syst. Nat., 12th ed., I, 1766, p. 157 (= *Cryptorhina afra*).

^e Latham's Allgem. Uebers. Vögel, II, 1794, p. 362.

^f Cat. Birds Brit. Mus., III, 1877, p. 247.

2. *Dicrurus adsimilis divaricatus* (Lichtenstein).

Muscicapa divaricata LICHTENSTEIN, Verz. Doubl. Zool. Mus. Berlin, 1823, p. 52 (Senegambia).

Edolius lugubris HEMPRICH and EHRENBURG, Symb. Phys., Aves, 1828, fol. s., pl. VII, fig. 3 (Ambukol, Dongola, Nubia).

Dicrurus canipennis SWAINSON, Birds West Afr., I, 1837, p. 254 (Senegal).

Dicrurus aculeatus CASSIN, Proc. Acad. Nat. Sci. Phila., 1851, p. 348 (Fazogl, Abyssinia).

Dicrourus erythrophthalmus HEUGLIN, Journ. f. Ornith., 1867, p. 294 (Württemberg, manuscript) (Senhaar, Egyptian Sudan; and Fazogl, Abyssinia).

Dicrurus fugax PETERS, Journ. f. Ornith., 1868, p. 132 (Tete and Inhambane, Portuguese East Africa).

Similar to *Dicrurus adsimilis adsimilis*, but very much smaller, the wing measuring only 118–130 mm.

Central and northern Africa, from Angola and Mashona Land to Somali Land, Nubia, the Sudan, and Senegal.

Examples from Angola are larger than those from more northern localities, and show in this a vergence toward true *adsimilis*, but they appear to be undoubtedly nearer *divaricatus*. So far as we have been able to determine from specimens examined, the birds from Senegal, Senegambia, Nubia, and Somali Land seem to be the same as those from German East Africa and the Zambesi River, so that the name *divaricatus* Lichtenstein, based on specimens from Senegambia, becomes available for this race. Mr. Oscar Neumann has recently shown the great difference in size which exists between *adsimilis* and *divaricatus*,^a but he employs for the latter the subspecific term *fugax* Peters,^b apparently overlooking the five prior names.

3. *Dicrurus adsimilis atactus* (Oberholser).

Dicrurus modestus atactus OBERHOLSER, Proc. U. S. Nat. Mus., XXII, 1899, p. 35 (Fantee, western Africa).

Like *Dicrurus adsimilis divaricatus* in size; but the wing-quills darker, more blackish; the plumage of upper and lower parts more velvety in appearance, with more of a bluish than a greenish metallic sheen. Coast region of central western Africa, from Liberia to the Niger River.

This form differs so much from both *adsimilis* and *divaricatus* in the velvety bluish color of the upper parts that Doctor Sharpe was induced to consider it the same as *Dicrurus modestus* [= *coracinus*], to which he referred his specimens from the Gold Coast.^c Misled by this the present writer described *atactus* as a subspecies of *modestus*,^d whereas there is now no doubt at all of its correct position as a subspecies of *D. adsimilis*. These differences, moreover, are not, as Captain Shelley infers,^e simply adventitious, but have a definite geographical significance.

^a Journ. f. Ornith., 1900, p. 277.

^b *Dicrurus fugax* PETERS, Journ. f. Ornith., 1868, p. 132.

^c Cat. Birds Brit. Mus., III, 1877, p. 233.

^d Proc. U. S. Nat. Mus., XXII, 1899, p. 35.

^e Ibis, 1901, p. 589.

Family CAMPEPHAGIDÆ.

CAMPEPHAGA FLAVA Vieillot.

Campephaga flava VIEILLOT, Nouv. Dict. d'Hist. Nat., X, 1817, p. 49 (female) (southern Africa).

Campephaga nigra VIEILLOT, Nouv. Dict. d'Hist. Nat., X, 1817, p. 50 (male) (southern Africa).

Four specimens: three from Taveta; and one from Mount Kilimanjaro, at 5,000 feet. A freshly molted female that seems to be immature, taken August 15, 1888, differs from an adult of the same sex in being a little more grayish on the anterior upper parts; rather paler on the sides of the head, particularly the auriculars; in having the black barring of scapulars, lower back, rump, and upper tail-coverts obsolescent (not simply obscured by the brown tips of the feathers), the upper surface consequently much more uniform in appearance; the yellow edgings of the wings paler, those of the tertials whitish; the upper throat almost immaculate; the lower throat and breast with more yellow; the flanks and crissum with a heavier wash of buff; the yellow margins of the tail-feathers lighter and duller; the lining of the wings paler yellow. There seems to be little or no difference in size between the sexes.

Although this species commonly passes as *Campephaga nigra*,^a the name *flava*, based on the female, occurs on the previous page,^b and should be used instead.

Family LANIIDÆ.

LANIUS CAUDATUS Cabanis.

Lanius caudatus CABANIS, Journ. f. Ornith., 1868, p. 412 (Mombasa, British East Africa).

Two specimens, both immature. One of these, a female taken June 28, 1888, on the plains near Taveta, is in almost completed molt, only a few of the feathers of the juvenal plumage remaining, and these chiefly on the back. The other example, a male from Lake Chala, near Mount Kilimanjaro, August 20, 1888, still has almost all of its juvenal plumage on the upper parts, though nearly pure white below.

The careful examination of a large number of species of *Lanius* has failed to reveal the presence of any satisfactory characters by which the so-called genera *Phoeniceus*, *Fiscus*, *Enneoctonus*, *Cephalophoeniceus*, and *Otomela* can be distinguished. It is true that there are some differences in the proportions of wing and tail, in the length and breadth of the outermost primary, in the graduation of the tail, and in the number of primaries sinuate on the outer web; but these all so closely

^a Vieillot, Nouv. Dict. d'Hist. Nat., X, 1817, p. 50.

^b Idem, p. 49.

and complicatedly interdigitate that it seems impossible to draw any lines of generic division. Even color, on which some writers rely to separate these groups, fails as a character. The proper course appears to be the mergence of all into the genus *Lanius*.

LANIUS COLLURIO Linnæus.

Lanius collurio LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 94 (Europe [type locality, Sweden]).

One specimen, an adult female in perfect plumage, from Maranu, Mount Kilimanjaro, at 5,000 feet, April 4, 1888.

LANIUS ISABELLINUS Hemprich and Ehrenberg.

Lanius isabellinus HEMPRICH and EHRENBURG, Symb. Phys., I, 1828, fol. e, note (Gumfudam, Arabia).

One adult male from Mount Kilimanjaro, 5,000 feet, December 29, 1889. It seems to be identical with birds from central Asia. "Bill dark horn-brown above, lower mandible white, black at tip; feet black."

LANIARIUS ABBOTTI Richmond.

Laniarius abboti RICHMOND, Auk, XIV, 1897, p. 161 (Mount Kilimanjaro, East Africa).

Malaconotus munningi SHELLEY, Bull. Brit. Orn. Club, VIII, No. LX, February, 1899, p. xxxv (Mambwe district, British Central Africa).

The only specimen obtained by Doctor Abbott is the one from which Doctor Richmond described this pretty species. It is an adult male, from Mount Kilimanjaro, at 5,000 feet, October 18, 1889. "Iris red."

There seems to be little doubt that the present species is identical with *Malaconotus munningi* Shelley, as Doctor Reichenow has already indicated.^a It differs from *Laniarius nigrifrons* Reichenow^b in its orange instead of yellow throat; its orange in place of golden brownish breast; and in the greater extent of the black band on the sides of the head, which in *abboti* involves the entire orbital and auricular regions.

The genus *Chlorophoneus* Cabanis^c appears to be inseparable from *Laniarius* unless quite arbitrary color characters be requisitioned, for there are no obvious structural differences, nor, indeed, does Doctor Reichenow adduce any save the clearly invalid one of a stouter bill for *Laniarius*.^d Mr. Neumann's *Cosmophoneus*^e is still less tenable, being simply a further refinement of *Chlorophoneus* purely on grounds of coloration.

^a Vögel Africas, II, 1903, p. 560.

^b Ornith. Monatsber., 1896, p. 95 (Marangu, Mount Kilimanjaro).

^c Mus. Hein., I, 1850, p. 70.

^d Vögel Africas, II, 1903, p. 571.

^e Journ. f. Ornith., 1899, p. 392 (type, *Lanius multicolor* Gray).

LANIARIUS SUBLACTEUS (Cassin).

Dryoscopus sublacteus CASSIN, Proc. Acad. Nat. Sci. Phila., V, 1851, p. 246 (eastern Africa?).

Three adults from Mount Kilimanjaro, at 5,000 feet. One of these, taken April 5, 1888, was molting the wing and tail-feathers. "Feet (of female) slate blue; bill black." The female of this species seems to be just like the male, except for rather darker feet and tarsi. All of these specimens have some white spots on the scapulars.

The slight difference in pattern of coloration, which alone appears to distinguish the so-called genus *Dryoscopus* from *Laniarius*, is hardly sufficient reason for the recognition of the former.

LANIARIUS FUNEBRIS (Hartlaub).

Dryoscopus funebris HARTLAUB, Proc. Zool. Soc. Lond., 1863, p. 105 (Meninga, Unyamwezi, German East Africa).

One specimen, a female, from Taveta, August 14, 1888. It is not quite mature, as is indicated by the narrow ochraceous edgings on the upper wing-coverts and by the yellowish barred feathers of the center of the abdomen.

LANIARIUS CUBLA HAMATUS (Hartlaub).

Dryoscopus hamatus HARTLAUB, Proc. Zool. Soc. Lond., 1863, p. 106 (Kazeh, Victoria Nyanza, German East Africa).

Dryoscopus cubla suahelicus NEUMANN, Journ. f. Ornith., 1899, p. 414 (Kakoma, German East Africa).

Three adult males from Taveta. The wing-feathers of one, taken March 23, 1888, are in process of molt. "Iris (of male) red."

POMATORHYNCHUS SENEGALUS SENEGALUS (Linnæus).

Lanius senegalus LINNÆUS, Syst. Nat., 12th ed., I, 1766, p. 137 (Senegal).

Two males: one from Taveta, May 1, 1888, the other from the plains of Taveta, June 28, 1888.

POMATORHYNCHUS AUSTRALIS MINOR (Reichenow).

Telephonus minor REICHENOW, Journ. f. Ornith., 1887, p. 64 (Kagehi, Victoria Nyanza, German East Africa).

Three specimens, from Mount Kilimanjaro, 4,000 feet, and Maranu, Kilimanjaro, 5,000 feet. One of these is apparently immature, to judge from its brown bill, and has the crown of a deeper brown. The lower parts more suffused with ochraceous than the two others.

Family PRIONOPIDÆ.

NILAUS AFER MINOR (Sharpe).

Nilaus minor SHARPE, Proc. Zool. Soc. Lond., 1895, p. 479 (Milmil, Sibbe, The Haud, and Okoto, western Somali Land).

One specimen from the Useri River, near Mount Kilimanjaro, August 30, 1888. It is a female, in which the black of the upper parts is replaced by brown, except on the rump and upper tail-coverts, and the white portions of the upper surface and tail are more buffy than in the adult male. This is the plumage supposed to characterize the immature bird, but the present example is apparently adult.

The most satisfactory difference between the Laniidæ and the Prionopidæ consists in the scutellation of the posterior portion of the lateral face of the tarsus in the forms of the latter family, whereas in Laniidæ this part is entire. Using this character as a criterion, *Nilaus* belongs in the Prionopidæ.

EUROCEPHALUS ANGITIMENS RUPPELLI (Bonaparte).

Eurocephalus ruppelli BONAPARTE, Rev. et Mag. Zool., 1853, p. 440 (White Nile, and Shoa, Abyssinia).

One adult male, from Taveta, August 14, 1888. It is decidedly smaller than a female from Somali Land, as well as much less brownish on the breast and sides. Its measurements are: Wing, 121; tail, 88; exposed culmen, 16.5; tarsus, 21; middle toe, 15.5 mm. As Neumann contends,^a this species is much better placed in the Prionopidæ than in the Laniidæ.

PRIONOPS VINACEIGULARIS Richmond.

Prionops vinaceigularis RICHMOND, Auk, XIV, 1897, p. 162 (plains east of Mount Kilimanjaro, British East Africa).

Three specimens, from which this very distinct species was originally described, were taken by Doctor Abbott on the plains east of Mount Kilimanjaro. "Feet (of male) red; iris yellow; bare skin around eyes green. Feet (of female) red; iris and skin around eyes yellowish green." The females lack the white edgings of the superior wing-coverts, a difference additional to those mentioned by Doctor Richmond.^b Measurements of these birds are as follows:

Sex.	Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.	Middle toe.
			mm.	mm.	mm.	mm.	mm.
Male	Plains east of Mount Kilimanjaro..	Oct. 1, 1888	103	84	17	21	14.5
Female	do	Oct. 6, 1888	106	87	18	22.5	15
Do	do	do	108	91	20	22	14.5

^a Journ. f. Ornith., 1900, p. 273.

^b Auk, XIV, 1897, p. 163.

SIGMODUS RETZII GRACULINUS (Cabanis).

Prionops graculinus CABANIS, Journ. f. Ornith., 1868, p. 412, pl. III (Mombasa, British East Africa).

One specimen from Kahé, south of Mount Kilimanjaro, taken September 5, 1888. It has a slight indication of a white bar on the under side of the wing, but this is confined to small areas on the edges of the inner webs of some of the primaries; and there seems to be no doubt of the correctness of the above identification.

Family ZOSTEROPIDÆ.

ZOSTEROPS SENEGALENSIS FLAVILATERALIS (Reichenow).

Zosterops flavilateralis REICHENOW, Journ. f. Ornith., 1892, pp. 192, 193 (East Africa).

Four specimens, from Taveta, and from Mount Kilimanjaro at 5,000 feet, belong to this form of *Zosterops senegalensis*. Captain Shelley is probably wrong in citing^a *flavilateralis* as a synonym of *Zosterops pallescens* Heuglin^b (= *Zosterops heuglini* Hartlaub^c), for the latter is much more probably the same as *Z. stuhlmanni* Reichenow^d or *Z. superciliosa* Reichenow,^e if indeed the last two are not also identical.

ZOSTEROPS EURYCRICOTA Fischer and Reichenow.

Zosterops eurycricotus FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 55 (base of Meru Mountains, Great Arusha, Masai Land, German East Africa).

Zosterops perspicillata SHELLEY, Proc. Zool. Soc. Lond., 1889 p. 366, pl. XLI, fig. 1 (Mount Kilimanjaro).

Eight specimens, all from Mount Kilimanjaro, at altitudes of 5,000, 6,000, and 10,000 feet. With the exception of the type, two specimens in the British Museum, and two recorded from Mount Kilimanjaro by Neumann,^f these appear to be the only ones of this rare species known. They generally agree very closely with published descriptions, but in one bird, taken at 10,000 feet in April, the forehead is almost as yellow as the throat, though darker, and the under parts are somewhat lighter yellow than in any of the rest of our series, while the upper surface has more of an olive tinge. The yellowish forehead can hardly be considered sufficient for the reference of this bird to *Zosterops stuhlmanni*,^g because other individuals are intermediate in this respect.

^a Birds of Africa, II, 1900, p. 176.

^b Journ. f. Ornith., 1864, p. 260 (Bongo).

^c Idem, 1865, p. 11 (Bongo).

^d Idem, 1892, p. 54 (Bukoba, German East Africa).

^e Idem, 1892, p. 193 (Wadelai, British Equatorial Africa).

^f Idem, 1900, p. 295.

^g Reichenow, Journ. f. Ornith., 1892, p. 192 (Bukoba, German East Africa).

The only other example collected by Doctor Abbott at the same altitude is a female, in which the forehead is similar to the remainder of the upper surface—a yellowish green with scarcely a trace of olive—and the yellow of the inferior surface is no lighter than usual. In one specimen the chin and two or three feathers of the throat are black—apparently a tendency toward melanism. An immature female is duller above than the adult, and paler, conspicuously less yellowish below, but otherwise is apparently not different. Male and female are seemingly just alike in color.

Family NECTARINIIDÆ.

ANTHREPTES ORIENTALIS Hartlaub.

Anthreptes orientalis HARTLAUB, Journ. f. Ornith, 1880, p. 213 (Lado, Upper White Nile, British Equatorial Africa).

One adult male, taken August 30, 1888, on the Useri River, near Mount Kilimanjaro.

It is quite probable that *Anthreptes orientalis* may prove to be but a subspecies of *Anthreptes longuemarii*, for though we have no series of either species, the variations noted by Captain Shelley^a point significantly in this direction.

ANTHREPTES COLLARIS ZAMBESIANUS (Sharpe).

Anthodiata zambesiana SHARPE, Layard's Birds S. Afr., 1876, p. 321 (Shupanga, Zambesi River near mouth of Shiré River, Portuguese East Africa).

Ten specimens, probably all from Taveta, though several have no locality indicated on the label.

Taking these specimens as a basis for comparison, *Anthreptes c. zambesianus* is a perfectly good race. It differs from *Anthreptes collaris* as does *A. c. hypodilus*—in the golden olive instead of metallic green edgings of the secondaries, greater and primary coverts;^b and still further in its larger size and much paler posterior lower parts. From *Anthreptes collaris hypodilus*, with which of course it is most nearly allied, it may readily be distinguished by the decidedly paler yellow of the under surface; by the rather lighter shade of the golden olive quill margins; and by somewhat larger size.

Among the adult males there is quite a noticeable variation in the color above, some specimens showing much more golden green than others. The adult females are not uniformly yellow below, but are shaded anteriorly with a considerable admixture of grayish, this coincident in extent with the metallic throat colors of the adult male. An immature male is similar.

^a Birds of Africa, II, 1900, p. 146.

^b In stating this distinction on a previous occasion (Proc. U. S. Nat. Mus., XXII, 1899, p. 33) I inadvertently transposed the terms "golden olive" and "metallic green."

CINNYRIS OLIVACEA RAGAZZII (Salvadori).

Eleocerthia ragazzii SALVADORI, Ann. Mus. Stor. Nat. Genova, Ser. 2^a, VI (XXVI) 1888, p. 247 (Fekerie Ghem forest, Shoa, Abyssinia).

Six specimens, from Mount Kilimanjaro (5,000, and 6,000 feet) and Taveta. There appears to be little, if any, color contrast between the sexes, though our single adult female is rather paler than the males, particularly below. A female in juvenal plumage, taken March 23, however, differs from the adult of the same sex in the total lack of pectoral tufts, and in the much more conspicuous yellow suffusion on the under surface, the throat being particularly bright.

This species, though superficially close to *Cinnyris obscura*, may easily be distinguished by its darker, more yellowish green lower parts, especially the throat, where the difference is striking; and particularly by the *entirely* black or brownish black bill—in *obscura* the base of the mandible being yellowish or brownish white. There is apparently no difference in dimensions between *obscura* and *ragazzii*; and the males of the latter in Doctor Abbott's collection measure, respectively, 65, 63, 62, and 60 mm. Young birds of *ragazzii* are much brighter than the corresponding plumage of *obscura*, particularly on the sides of neck and head, and on the lower surface, which last is much more deeply yellowish, especially on the throat.

Altogether there does not seem to be the slightest reason for synonymizing *Cinnyris ragazzii* with *C. obscura*, as has been done by Captain Shelley;^a since, in fact, the former is probably really more closely allied to *Cinnyris olivacea* from South Africa, of which it is apparently but a northern subspecies, and from which it differs in smaller size, particularly the bill, and in paler, duller coloration of the lower parts. With *Cinnyris obscura neglecta*^b from East Africa our specimens do not agree, being more greenish below than *obscura*, while *neglecta* is described as less so. Since both *Cinnyris obscura neglecta* and *Cinnyris olivacea ragazzii* occur over the same areas in at least parts of East Africa and possibly Abyssinia, they must be regarded as distinct species. Thus we have altogether four forms, with geographical distribution approximately as follows:^c

Cinnyris olivacea olivacea SMITH. South Africa.

Cinnyris olivacea ragazzii (SALVADORI). East Africa to Abyssinia.

Cinnyris obscura obscura (JARDINE). West Africa, from Liberia to the Kongo; and Central Africa.

Cinnyris obscura neglecta (NEUMANN). East Africa.

There seem to be no characters sufficient for the separation of *Cyanomitra* from *Cinnyris* proper.

^a Birds of Africa, II, 1900, pp. 125, 127.

^b *Cyanomitra obscura neglecta* Neumann, Journ. f. Ornith., 1900, p. 297 (Kibuesi, Ukamba, British East Africa).

^c *Nectarinia olivacea* Peters, Journ. f. Ornith., 1881, p. 50, from Inhambane, Portuguese East Africa, is doubtfully distinct.

CINNYRIS AFFINIS FALKENSTEINI (Fischer and Reichenow).

Cinnyris falkensteini FISCHER and REICHENOW, Journ. f. Ornith., 1884, p. 56 (Lake Naivasha, British East Africa).

Ten specimens, eight of them adult males, from Mount Kilimanjaro, at 4,000 and 5,000 feet, collected in April, June, September, and November. Doctor Abbott reports this bird abundant at the latter elevation.

The West African *Cinnyris venusta* seems to be a distinct species; but the above series indicates that *Cinnyris falkensteini* is but a subspecies of *C. affinis*. Every character adduced to separate *C. falkensteini* from *C. affinis* our adult males show to be more or less inconstant. The throat sometimes is noticeably greenish entirely across its middle portion; the abdomen and lower breast are light yellow; the upper parts, except the crown and superior tail-coverts, show scarcely a tinge of bluish; and the brown of the under wing-coverts is mixed with ashy.

An adult female is olive brown above, the tail and its upper coverts black with dull metallic green edgings; wings fuscous, inconspicuously paler margined; a poorly defined light brownish superciliary stripe; sides of head and neck like the back; lower surface pale yellow, shaded with olive on the throat and upper breast; lining of wing pale yellow.

An immature male differs from the adult female in the possession of orange pectoral tufts; rather darker upper parts, with some admixture of the new metallic feathers; more deeply yellow posterior lower parts; and metallic feathers on the median portion of the throat. Probably in the entire first plumage, before the molt has begun, the young male is quite like the adult female.

CINNYRIS MEDIOCRIS Shelley.

Cinnyris mediocris SHELLEY, Proc. Zool. Soc. Lond., 1885, p. 228 (Mount Kilimanjaro, 12,000 feet, East Africa).

Twelve specimens, all but one adult males, from Mount Kilimanjaro, at 5,000 and 6,000 feet altitude. Some of the males have the upper parts much less golden green than others, and one has the lower tail-coverts tipped with reddish.

CINNYRIS KIRKII Shelley.

Cinnyris kirkii SHELLEY, Mon. Nect., 1876, p. 273, pl. LXXXV (Shupanga, Zambesi River near mouth of Shiré River, Portuguese East Africa).

Eleven specimens: from Taveta; Mount Kilimanjaro (5,000 feet); Kahé, south of Mount Kilimanjaro; and Aruscha-wa-chini. An immature male, taken December 6, 1889, has the dark-brown body plumage curiously mottled with buffy and pale-brownish tipped feathers.

We fail to discover any satisfactory characters to serve for the recognition of the genus *Chalcomitra*.

HELIONYMPHA,^a new genus.

Chars. gen.—Similar to *Cinnyris*, but tail very much longer than wing, the central feathers narrow and elongated, projecting nearly 20 millimeters beyond the others.

Type.—*Cinnyris nectarinioides* Richmond.

The above-presented characters so trenchantly separate this form from all the others of this intricate group that there seems little question of the propriety of instituting this new genus. From *Æthopyga* it may be distinguished by the more strongly curved bill, and by the shape of the tail, which is, with the exception of the long middle feathers, rounded instead of wedge-shaped. It is so widely different from *Nectarinia* and *Hedydipna* that no formal comparison is necessary.

HELIONYMPHA NECTARINIOIDES (Richmond).

Cinnyris nectarinioides RICHMOND, Auk, XIV, 1897, p. 158 (plains east of Mount Kilimanjaro, East Africa).

Two adult males—one the type of the species, the other from Aruscha-wa-chini, southwest of Mount Kilimanjaro. To the remarks of Doctor Richmond^b there is nothing to be added, except that the broad pectoral band of the second specimen is deep reddish orange instead of vermilion.

NECTARINIA CUPREONITENS Shelley.

Nectarinia cupreonitens SHELLEY, Mon. Nect., 1876, p. 17, pl. vi, fig. 1 (Abyssinia).

One specimen, an immature male, from Mount Kilimanjaro, 5,000 feet, December 14, 1889. It is in process of acquiring the full green plumage. If *Nectarinia xeneigularis* Sharpe^c is really even subspecifically distinct from *N. cupreonitens*, of which we are not at all assured, our bird of course belongs to the former. This species is indeed very close to *N. famosa*, and were it not for the peculiar shape of the slender bill we should be inclined to consider it but a subspecies of the latter.

NECTARINIA JOHNSTONI Shelley.

Nectarinia johnstoni SHELLEY, Proc. Zool. Soc. Lond., 1885, p. 227 (Mount Kilimanjaro, 11,000 feet, East Africa).

Of this rare, beautiful, and interesting sunbird Doctor Abbott obtained a fine series of ten adult males in perfect plumage, together with two adult females. They were collected in November and Decem-

^a ἥλιος, sol; νύμφη, nymphe.

^b Auk, XIV, 1897, p. 158.

^c Ibis, 1891, p. 444 (Sotik, British East Africa).

ber, at altitudes of 10,000 and 11,000 feet on Mount Kilimanjaro. Doctor Abbott writes that they live in the scattered, stunted trees above the forest zone, and that they were very common at an elevation of 11,000 feet, in November, 1888.

This is a species certainly very distinct from *Nectarinia famosa*, the male differing from the same sex of the latter, as indicated by its describer, in possessing bright scarlet instead of yellow pectoral tufts, and in having much longer central tail-feathers which in fully developed condition exceed those of *N. famosa* by 30 to 50 millimeters. Other distinctions, two of them quite as marked as those already noted, and to which little if any attention seems to have been called, are the somewhat shorter bill of *johnstoni*; the very decidedly more glittering or shining appearance of the entire body plumage, and the total lack of metallic green on the lower abdomen and under tail-coverts, which parts are dull bluish black, with scarce a hint of metallic reflections, often some of the feathers even tipped with pale brownish. Among all the males there is very little individual color variation, such as there is consisting in a more golden cast to the metallic green of the upper and lower parts, most noticeable anteriorly.

The female, which seems never to have been described, is much smaller than the male, and differs from the female of *Nectarinia famosa* in being decidedly darker both above and below, with the pileum appreciably more deeply colored than the back, instead of concolor; the exterior tail-feathers lack the white outer webs and the conspicuous white tips of the inner vanes; reddish orange pectoral tufts are present; there is no decided yellow on the cheeks or chin and very little on the abdomen; the bill is slightly shorter. The following description of one of these specimens may prove of interest:

Adult female, Cat. No. 119193, U. S. Nat. Mus.; Mount Kilimanjaro (10,000 feet), December 15, 1889. Upper parts sepia brown, the pileum, wings, and tail darker than the rest, and with slight bluish and greenish metallic reflections, most noticeable on the tail; superciliary stripe, cheeks, and chin dull brownish buff; remainder of lower surface sepia brown, rather lighter than that of the upper parts, the center of the abdomen pale yellowish, the under tail-coverts broadly margined with yellowish white, a small reddish orange tuft on each side of the breast; lining of wing yellowish white mixed with brownish. Length of wing, 72; tail, 49; exposed culmen, 29; tarsus, 18; middle toe, 12 mm.

NECTARINIA TACAZZE UNISPLENDENS Neumann.

Nectarinia takaze unisplendens NEUMANN, Journ. f. Ornith., 1900, p. 300 (Kifinika, Mount Kilimanjaro, East Africa).

A single adult male from Mount Kilimanjaro, 6,000 feet, December 16, 1889, does not, so far as we can discover, differ much from the descriptions of typical *Nectarinia tacaze* from Abyssinia,^a but no specimens of the latter are available. *Nectarinia jacksoni*^b is a very dubious form, probably nothing more than an individual variation of *N. tacaze*; and the same is possibly true of *unisplendens*.

DREPANORHYNCHUS KILIMENSIS (Shelley).

Nectarinia kilimensis SHELLEY, Proc. Zool. Soc. Lond., 1884, p. 555 (Mount Kilimanjaro—5,000 feet—East Africa).

Seven adult males, from Mount Kilimanjaro, at 5,000 feet altitude, taken in April, June, and August. Doctor Abbott writes that the species is common at 5,000 feet on the mountain, but is not found at a much greater elevation.

This species differs very markedly from *Nectarinia tacaze* in the shorter, much more curved bill, and in the presence of a narrow naked median line on the forehead—in these characters agreeing much more closely with *Drepanorhynchus reichenowi*, although in neither respect quite so extreme.

DREPANORHYNCHUS REICHENOWI Fischer.

Drepanorhynchus reichenowi FISCHER, Journ. f. Ornith., 1884, p. 56 (Lake Naivasha, British East Africa).

Of this magnificent species Doctor Abbott secured a fine series of 13 adults—10 males and 3 females—on Mount Kilimanjaro, at altitudes of 5,000 and 6,000 feet, in April, August, and December. The four males taken in December are much tinged with golden green above, which difference from all the others is very possibly due to season and to the abrasion of the feathers.

This species has a very strongly curved bill, and in both male and female a narrow naked median line parting the feathers of the forehead—characters shared by *Nectarinia kilimensis*, and which seem of generic significance. In every one of the other species of *Nectarinia* examined, and we have seen all except *N. melanogastra* and *N. bocagii*, the frontal feathers form almost a straight line across the base of the culmen.

^a *Certhia tacaze* Stanley, in Salt's Voyage Abyss., 1814, App. iv, p. lviii (Tacaze River, Tigré, Abyssinia).

^b *Nectarinia jacksoni* Neumann, Ornith. Monatsber., 1899, p. 24 (Mau, British East Africa).

Family HIRUNDINIDÆ.

PSALIDOPROCNE HOLOMELAS MASSAICA Neumann.

Psalidoprocne holomelæna massaica NEUMANN, Ornith. Monatsber., 1904, p. 144 (Kikuyu, British East Africa).

This recently described form is similar to *Psalidoprocne holomelas holomelas*, but much larger; the inferior wing-coverts and axillars are paler brown, and the greenish metallic sheen of the plumage is more pronounced.

The description of an adult male, Cat. No. 118125, U. S. Nat. Mus., collected by Doctor Abbott at Maranu on Mount Kilimanjaro; 5,000 feet, April 23, 1888, is as follows: Entire upper and lower parts black with a decided greenish gloss; wings and tail deep blackish brown, exteriorly with the same greenish tinge, the wing-quills lighter brownish on at least the basal portion of the inner webs; under wing-coverts and axillars still paler grayish brown. Four adult males, including the one above described, measure as below:

Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.
Maranu, Mount Kilimanjaro, 5,000 feet...	Apr. 23, 1888	mm. 114	mm. 94	mm. 5.5	mm. 10
Do.....do.....	do.....	111	94	5.5	9
Do.....do.....	do.....	112.5	92	5	9
Foot of Mount Kilimanjaro, 3,000 feet...	Apr. 25, 1888	113.5	104	5.5	11
Average.....		112.8	96	5.4	9.8

A specimen of true *holomelas*, of about average size, from Pinetown, Natal, measures: Wing, 104; tail, 80; exposed culmen, 5; tarsus, 9 mm.

Mr. Neumann failed to mention the much greater size, which is one of the best characters distinguishing this new form from the South African *holomelas*. The range of *massaica* probably includes the greater part, if not all, of German East Africa, and extends northward to Mount Kenia, and to Mount Elgon whence it has been recorded as *Psalidoprocne orientalis* by Mr. Jackson.^a

True *Psalidoprocne holomelas* was described by Sundevall^b from specimens collected at Port Natal, Natal, and is therefore the small South African race, to which also clearly apply both the other synonyms of the species.^c

Besides the four specimens listed above, Doctor Abbott obtained a single immature male at Taveta, August 19, 1888, which differs from

^a Ibis, 1901, p. 95. See Shelley, Ibis, 1901, pp. 171-172.

^b *Hirundo holomelas* Sundevall, Öfv. K. Vet.-Akad. Förh. Stockholm, 1850, p. 108.

^c *Atticora hamigera* Cassin, Proc. Acad. Nat. Sci. Phila., 1850, p. 57, pl. XII (Port Natal, Natal).

Psalidoprocne cypselina Cabanis, Mus. Hein., I, 1850, p. 48 (South Africa).

the adult in its noticeably more brownish plumage, particularly on the rump and abdomen, and in its darker brown inferior wing-coverts and axillars.

HIRUNDO MONTEIRI Hartlaub.

Hirundo montei HARTLAUB, Ibis, 1862, p. 340, pl. XI (Massangano and Cam-bambe, Angola).

Four specimens, from Kahé, south of Mount Kilimanjaro. The female is rather duller on the upper surface than the male, and is smaller, with less well-developed lateral tail feathers. Both female and immature have the innermost secondaries tipped with buff.

HIRUNDO PUELLA ABYSSINICA (Guérin).

Hirundo abyssinica GUÉRIN, Rev. Zool., 1843, p. 322 (Abyssinia).

Two adult specimens, male and female, from Taveta.

There are undoubtedly at least two easily distinguishable races of *Hirundo puella*: one confined to western Africa, the other to the eastern part of the continent but ranging from Cape Colony to Abyssinia. The first description of *Hirundo puella*^a was based on the bird from the coast of Guinea, and consequently is applicable to the west African form; and of this *Hirundo korthalsi* Bonaparte,^b from an unknown locality, is apparently a synonym. For the eastern bird there is available *Hirundo abyssinica* Guérin,^c described from Abyssinia, and shortly afterwards renamed by Rüppell *Cecropis striolata*^d on specimens from the same region. The eastern bird stands, therefore, as *Hirundo puella abyssinica*, and differs from *Hirundo puella puella* in larger size; much more broadly streaked lower parts, particularly on sides and abdomen; more whitish (less rufescent) crissum, sides, flanks, and lining of wing; rather paler rump and pileum. The table of measurements in Sharpe and Wyatt's Monograph of the Hirundinidæ (pages 342-343) so well exhibits the difference in size between the two forms that further measurements are really not necessary.

The dimensions of Doctor Abbott's examples, however, are as follows:

U. S. N. M. No.	Sex.	Locality.	Date.	Wing.	Tail.	Exposed culmen.	Tarsus.
118122	Male	Taveta	Feb. 7, 1889	mm. 110	mm. a 95	mm. 6.5	mm. 14
118123	Female .....	.....do.....	.....do.....	107	89	6.5	13

^a Imperfect.

^a Temminck and Schlegel, Fauna Japonica, Aves, 1842, p. 34.

^b Consp. Avium, I, 1850, p. 340.

^c Rev. Zool., 1843, p. 322.

^d Syst. Uebers. Vög. Nord.-Ost.-Afr., 1845, p. 18, pl. vi.

HIRUNDO EMINI Reichenow.

Hirundo emini REICHENOW, Journ. f. Ornith., 1892, pp. 30, 215 (Bussisi and Bukoba, Victoria Nyanza, German East Africa).

Two specimens, from Lake Chala, and from Maranu, Mount Kilimanjaro, at 5,000 feet, respectively. The former is an immature female, taken July 1, 1888, and differs from the adult male in smaller size; broader, less lengthened lateral tail-feathers; paler abdomen; duller upper parts; ochraceous rump, in which chestnut feathers are just making their appearance; secondaries and inner primaries either very narrowly tipped, or edged on distal portion of inner webs with cream white; and tertials rather conspicuously tipped with buff. This species, it will be noted, is another of those that were undescribed when Doctor Abbott's specimens were collected.

HIRUNDO RUSTICA Linnæus.

Hirundo rustica LINNÆUS, Syst. Nat., 10th ed., I, 1758, p. 191 (Europe [type locality, Sweden]).

Three specimens: one adult female from Kahé, south of Mount Kilimanjaro, September 6, 1888; and two immature males from Mount Kilimanjaro, one of these taken November 15, 1888, at 8,000 feet, the other November 20, at 10,000 feet.

Family **MOTACILLIDÆ**.**MACRONYX AURANTIIGULUS** Reichenow.

Macronyx aurantiigula REICHENOW, Journ. f. Ornith., 1891, p. 222 (Pangani River, German East Africa).

Three apparently typical specimens, from the plains near Mount Kilimanjaro, and Aruscha-wa-ehini, southwest of Kilimanjaro. There is no observable difference between the sexes.

MOTACILLA VIDUA Sundevall.

Motacilla vidua SUNDEVALL, Öfv. K. Vet.-Akad. Förh. Stockholm, 1850, p. 128 (Kaffir Land, South Africa).

Three specimens, from Taveta, March 27 and 28, 1888. One of these is an adult in perfect black-backed plumage; the two others are immature birds with dark grayish brown upper parts, and some narrow white edgings to the black feathers of the pectoral crescent.

BUDYTES CAMPESTRIS (Pallas).

Motacilla campestris PALLAS, Reis. Russ. Reichs, III, 1776, p. 696 (Russian Empire).

One female, from the plains east of Mount Kilimanjaro, January, 1889. It is an immature bird with yellowish olive green upper parts, and lower surface posteriorly much mixed with white.

Family FRINGILLIDÆ.

EMBERIZA FLAVIVENTRIS (Vieillot).

Passerina flaviventris VIEILLOT, Encyc. Méth., III, 1823, p. 929 (Cape of Good Hope, South Africa).

One immature male, with wing-quills in process of molt, from the plains east of Mount Kilimanjaro, October 5, 1888.

CRITHAGRA ALBIFRONS Sharpe.

Crithagra albifrons SHARPE, Ibis, 1891, p. 118 (Kikuyu, British East Africa).

Crithagra kilimensis RICHMOND, Auk, XIV, 1897, p. 155 (Mount Kilimanjaro, East Africa).

Two specimens, from Mount Kilimanjaro, at 6,000 and 7,000 feet, respectively. One taken April 16, 1888, is evidently immature and is much more rufescent or ochraceous—less grayish—both above and below than the other, but is not otherwise importantly different. These examples formed the basis of Doctor Richmond's *Crithagra kilimensis*, which seems now to be identical with *Crithagra albifrons* of Sharpe.

There appears to be no good reason for not recognizing the genus *Crithagra* as different from *Serinus*, since the large, turgid bill and relatively short wings of the former group are alone sufficient to maintain its distinctness.

CRITHAGRA STRIOLATA AFFINIS Richmond.

Crithagra striolata affinis RICHMOND, Auk, XIV, 1897, p. 156 (Mount Kilimanjaro, East Africa).

Five specimens, from Mount Kilimanjaro, at 5,000, 6,000, and 7,000 feet. These, by reason of their yellowish chins, dark colors, and small size, seem to indicate that the southern examples of *Crithagra striolata* are subspecifically separable from those of Abyssinia. An immature bird taken at Maranu, 5,000 feet, on Mount Kilimanjaro, April 17, 1888, is rather paler, more ochraceous above than the adults.

SERINUS FLAVIVERTEX (Blanford).

Crithagra flavivertex BLANFORD, Ann. and Mag. Nat. Hist., 4th ser., VI, 1869, p. 330 (Adigrat, Tigré, Abyssinia).

Two specimens, from Mount Kilimanjaro, 10,000 feet, December 15, 1889. One of these is an immature bird still partially in juvenal plumage, and differs from the adult in being duller and more greenish on the upper parts, the pileum yellowish olive green streaked with dark brown, on the hind neck some brown and buffy streaked feathers of the earlier plumage persisting; yellow edgings of wings and tail paler, those of the greater and median wing-coverts particularly so;

lower surface much paler throughout, the breast and jugulum buffy mixed with a little yellow and streaked with dark brown, this streaking extending also to the flanks, the crissum yellowish white; lining of wing grayish and whitish, with but little wash of yellow.

PETRONIA PYRGITA (Heuglin).

Xanthodina pyrgita HEUGLIN, Journ. f. Ornith., 1862, p. 30 (Bogos Mountains, Abyssinia).

Two specimens: plains east of Mount Kilimanjaro, October 3, 1888; and Useri River, near Mount Kilimanjaro, August 30, 1888. One of these is immature, and has an evident though not conspicuous light brown superciliary stripe; the yellow throat patch is smaller and much paler than in the adult; the rest of the lower surface is also lighter; otherwise it does not differ. Two specimens of this species from Somali Land are decidedly more grayish both above and below than those obtained by Doctor Abbott, but whether this is geographical or individual our material is not sufficient to determine.

A DESCRIPTIVE LIST OF A COLLECTION OF EARLY STAGES OF JAPANESE LEPIDOPTERA.

By HARRISON G. DYAR,
Custodian of Lepidoptera.

This collection was prepared by Mr. Y. Nawa, of Gifu, Japan, and exhibited at the Louisiana Purchase Exposition in St. Louis, Missouri. Afterwards it was brought to Washington by Mr. U. Nawa and presented to the U. S. Department of Agriculture. The specimens are now in the U. S. National Museum.

Fifty-four species are represented, the adults, with pupæ, larvæ, and eggs of many, at least the larvæ of all. Of many of the species I find no published account of the early stages, and these are therefore described in this paper. Most of the species are of economic importance, being injurious to cultivated plants.

Family PAPILIONIDÆ.

PAPILIO SARPEDON Linnæus.

AOSUJI-AGEHA-CHŌ.

Food plant: *Cinnamomum camphora*.

The larva agrees in general with the excellent figure by Scott,^a but is less diversified in color. It is entirely velvety green, with faint lighter spottings, the thorax being dark green, and not of a different yellowish shade. There is no violet shading subventrally nor on the terminal abdominal segments as in the Australian larva. The subventral and pedal lines are pale yellow. The subdorsal angles of the metathoracic segment are blunt and rounded, not long and pointed as in Scott's figure. They are yellow with a black ring at the base. The scent organ is protruded in the specimen, but has been broken.



FIG. 1.—PAPILIO SARPEDON, LARVA.

^a Australian Lepidoptera, Australian Museum, Sydney, II, 1891, pl. xvii.

PAPILIO ALCINOUS Klug.

This species is not represented in the Nawa collection, but the U. S. National Museum has it from the collection exhibited at Chicago in 1893, which was presented by Professor Mitsukuri. I refer to it on account of the peculiar larva, which is the most generalized of the three now referred to, namely, *alcinous*, *demetrius*, and *xuthus*. It is allied to the American *philenor*, and retains in the last stage the peculiar black and white coloration, resembling bird excrement, so characteristic of most all young Papilios. The tubercles are produced into smooth papillæ, all of about equal length, about three times as long as wide at base.



FIG. 2.—PAPILIO ALCINOUS, LARVA.

PAPILIO DEMETRIUS Cramer.

KURO-AGEHA-CHŌ.

Food plant: *Citrus nobilis*.

The young larva resembles bird excrement. It is lilaceous brown, with a white saddle and lateral shades on thorax and abdominal segments 7 and 8. The tubercles show rather prominently at the extremities and are pilose. There are numerous small black markings, of which subdorsal spots on second and seventh abdominal segments are the largest. The shape is normal.

The mature larva is largely green. Head oval, rounded, brown. Meso- and meta-thorax enlarged, swollen, smooth. Bright green; subdorsal ocellar mark on metathorax oval, black, with reddish central dash, reddish ring and fine black line. The pair are joined across the dorsum by a series of eight spots in two rows, black rings on a slightly yellowish field. Subventral region of thorax purplish, the color reaching up into the posterior metathoracic incisure to form a band across; on anterior edge of first abdominal segment a black band. The purple color continues along subventral region of abdomen and rises on the fourth, sixth, and ninth segments in a white triangular blotch, from which a purple and white mottled band runs obliquely backward on segments 4 and 5, joining dorsally on 5 posteriorly; on segment 7 it rises more vertically and forms a subdorsal patch on the posterior edge of the segment. Anal segment whitish and purple. The larva is smooth without traces of tubercles.



FIG. 3.—PAPILIO DEMETRIUS, LARVA.

PAPILIO XUTHUS Linnæus.

AGEHA-NO-CHŌ.

Food plant: *Citrus nobilis*.

The adult has a marked resemblance to *P. machaon* Linnaeus; but that this is of no systematic value and is probably mimetic, is shown by the larva, which is nearly allied to that of *demetrius*. The young larva is not preserved in the collection before me, so I can not say whether the primitive coloration persists to the penultimate stage or not, though it apparently does, since Graeser remarks^a on its resemblance to the excrement of birds.

The mature larva is smooth, dark green, the metathoracic ocellar mark much as in *demetrius*, joined by an irregular black line, which is imperfectly broken into ringlets. The subventral coloration is modified from the primitive mottled purple of *demetrius* to a darker shade of green, and the white exists as concrete triangular blotches on the bases of the feet. The four transverse bands of the subventral color in the posterior metathoracic incisure, on abdominal segments 4-5, 7, and 10, respectively, are olivaceous shaded and edged with fine black lines. The positions of the obsolete tubercles are shown by reddish spots.



FIG. 4.—PAPILIO XUTHUS, LARVA.

PAPILIO MACHAON Linnæus.

KI-AGEHA-CHŌ.

Food plant: *Daucus carota*.

This larva is well known in Europe, and Japanese specimens present the characteristic appearance. The larva of the American *P. polyxenes* is marked with the same pattern.

Family PIERIDÆ.

PIERIS RAPÆ Linnæus.

MON-SCIO-CHŌ.

Food plant: *Brassica chinensis*.

The well-known "cabbage worm" of Europe, now spread over the world. The larvæ are normal, as remarked by Pryer.^b

^aBerl. Ent. Zeit., p. 1888, p. 62.^bLeech, Butt. China, Jap. and Corea, II, 1894, p. 458.

Family NYMPHALIDÆ.

VANESSA XANTHOMELAS Schiffermüller.

HIODOSHI-CHŌ.

Food plant: *Celtis sinensis*.The larva agrees with European specimens as figured by Hofmann.^a

PYRAMEIS CARDUI Linnæus.

HIME-AKATATEHA-CHŌ.

Food plant: *Arcticum lappa*.

The larva of this widespread species is generally known on thistle, but has several other food plants.

Family LYCAENIDÆ.

POLYOMMATUS BAETICUS Linnæus.

URANAMI-SHIJIMI-CHŌ.

Food plant: *Dolichos lablab*.The larva is of the dark form mentioned by Doctor Lang.^b

Family HESPERIIDÆ.

PARNARA GUTTATA Bremer and Grey.

ICHIMOJI-SESERI.

Food plant: *Oryza sativa*.

The larva forms a house of rice blades. The head is high, rounded triangular, vertical suture depressed, whitish, the suture and posterior rim of occiput narrowly black. Body small at joint 2, else robust, cylindrical; transparent whitish, thin skinned, minutely pilose. Cervical shield narrow, transverse, whitish, with a black linear posterior edge.

The pupa is inclosed in the larval house.

Family SPHINGIDÆ.

CEPHNODES HYLAS Linnæus.

O-SUKASHIBA.

Food plant: *Gardenia florida*.The larva is acceptably figured by Nagano.^c^a E. Hofmann, Die Baupе der Gross-Schmett. Europas, 1893, pl. vi, fig. 12.^b Butt. Eur., 1884, p. 99.^c Nawa, Icones Japonicorum Insectorum, I, 1904, pl. I, fig. 6.

GURLECA MASURIENSIS Butler, var. SANGAICA Butler.

HIME-HOJAKU.

Food plant: *Paederia tomentosa*.The larva is figured by Nagano.^a

THERETRA JAPONICA de l'Orza.

KO-SUZUME.

Food plant: *Vitis vinifera*.

The larva is figured by Nagano,^b but the figure does not bring out the subdorsal ring marks on the anterior abdominal segments prominently enough.

THERETRA OLDENLANDIÆ Fabricius.

SESUJI-SUZUME.

Food plant: *Colocasia antiquarum*.

The larva is figured by Nagano,^c but the specimens before me are more distinctly marked, with larger, brighter ring marks and more distinct yellow thoracic dots.

THERETRA NESSUS Drury.

SUZUME-GA.

Food plant: *Dioscorea japonica*.The larva is well figured by Nagano.^d

PERGESA ELPENOR Linnæus, var. LEWISI Butler.

BENI-SUZUME.

Food plant: *Oenothera biennis*, var. *lamarckiana*.

The larva before me is much darker than Nagano's figure,^e being entirely black and brown, all the green color obscured. It is the dark form which Nagano describes as the "first form."

This species is called by Rothschild and Jordan *Pergesa elpenor*, var. *lewisi* Butler, and they give Japan and China as localities. I can, however, hardly separate it from a specimen of *rivularis* Boisduval (= *fraterna* Butler) from Sikkim, and I think the species is a race of *rivularis* rather than *elpenor*, if these names really represent distinct species.

^aPlate III, fig. 5.^bPlate I, fig. 3.^cPlate I, fig. 2.^dPlate IV, fig. 6.^ePlate III, fig. 2.

HERSE CONVULVULI Linnæus.

EBIGARA-SUZUME.

Food plant: *Ipomœa batatas*.

The larva is figured by Nagano,^a who gives the green form. The specimen before me is of the brown one.

ACHERONTIA STYX Westwood, var. CRATHIS Rothschild and Jordan.

MENGATA-SUZUME.

Food plant: *Sesamum indicum*.

The larva is figured by Nagano.^b This form is given a new name, *crathis*, by Rothschild and Jordan. It is the *medusa* of Butler, not of Moore.

PSILOGRAMMA MENEPHRON Cramer, var. INCRETA Walker.

SHIMOFURI-SUZUME.

Food plant: *Paulownia tomentosa*.

The larva is figured by Nagano,^c who gives the green form. One of the specimens before me is like this, the other is heavily spotted with purplish brown.

HYLOICUS CALIGINEUS Butler.

KURO-SUZUME.

Food plant: *Pinus densiflora*.

The larva is figured by Nagano.^d My specimen agrees with the figure, but is rather larger and better fed.

MARUMBA GASCHKEWITCHI Bremer and Grey, var. ECHEPHRON
Boisduval.

MOMO-SUZUME.

Food plant: *Prunus persica*, var. *vulgaris*.

The larva is figured by Nagano.^e

SPHINX PLANUS Walker

UCHI-SUZUME.

Food plant: *Salix* sp.

The larva is figured by Nagano.^f

^a Plate I, fig. 5.

^b Plate I, fig. 4.

^c Plate II, fig. 3.

^d Plate II, fig. 4.

^e Plate II, fig. 2.

^f Plate I, fig. 1.

Family SATURNIIDÆ.

ACTIAS SELENE Hübner, var. ARTEMIS Bremer.

O-AO-GA.

Food plant: *Alnus maritima*.

The larva is green, with tubercles rather large, yellow with black basal rings, the subdorsal ones of joints 3 and 4 and single dorsal one of joint 12 larger than the others. Tubercle hairs black; white secondary hairs scattered over the body. A yellow substigmatal line. Spiracles red with yellow center. Head and joint 2 green, anal plates and tips of anal abdominal feet red brown, edged with yellow.

This form is close to the Asiatic *selene*, but the larva has a distinct lateral line which is not mentioned by Moore for *selene* nor shown in his figure.^a

CALIGULA JAPONICA Moore.

KURI-KEMUSHI.

Food plant: *Castanea vulgaris*, var. *japonica*.

Doctor Packard has described the larva at length, giving all the stages.^b

Family ARCTIIDÆ.

CAMPTOLOMA INTERIORATA Walker.

SARASA-MON-GA.

Food plant: *Quercus serrata*.

Hampson classes this genus among the Arctiidae in his Moths of India (1894) and is followed by Leech;^c but I think it might be better placed in the Noctuidæ. Hampson has in fact omitted the genus from the Arctiidae in the Cat. Lep. Phalænæ (1901). Vein 8 of the hind wings is united to vein 7 for a short distance at base, which is characteristic of the Arctiidae, but the larva is a Noctuid. It does not appear to be a degenerate form, the arrangement of the single hairs appearing primitive. Apparently we have here the origin of the Arctiidae from the Noctuidæ. The eggs are laid in a mass on the back of the leaf, entirely covered by the dark-red scales from the abdomen of the female moth. The specimens before me are shrunk, but appear to have been spheroidal, about one-half as high as wide, evenly rounded, circular from vertical aspect, smooth without prominent sculpture, whitish; diameter about 0.6 mm.



FIG. 5.—CAMPTOLOMA INTERIORATA, LARVA.

^a Lep. Ceylon, II, 1883, p. 124, pl. cxxvi, fig. 1a.

^b Proc. Am. Acad. Arts and Sci., XXXIX, 1904, p. 564.

^c Trans. Ent. Soc. Lond., 1899, p. 164.

Four fully grown larvæ are preserved. The head is elliptical, higher than wide, scarcely bilobed, smooth, black with a few faint whitish reticulated lines, of which one straight across the front above clypeus is most distinct. Body cylindrical, smooth, slightly tapered at the end. Cervical shield large, dull black, quadrate, bisected; thoracic feet, abdominal foot shields and anal plate likewise black. Body dark brown with numerous pale yellowish lines. These are dorsal, addorsal (tubercle i), upper subdorsal, lower subdorsal (tubercle ii), upper lateral, lateral (tubercle iii), stigmatal (tubercle iv), upper subventral (tubercle v), lower subventral (tubercle vi), the lines more or less flexuous, slightly anastomosed, the subventral ones more irregular and confused. Tubercles single, small, dark, with long coarse white setæ; on the abdomen i dorsad to ii, iii suprastigmatal, iv stigmatal posterior, v subventral, vi lower subventral, normal; a hair on the leg shield. On the thorax ia to iib separate, nearly equally spaced, iib rather smaller; cervical shield covering all the six hairs.

The cocoon is a tough, silken sack, cylindrical, sharply compressed at the front end, with an open slip for emergence, covered by loose silk.

The pupa is thick and robust, brown, entirely without cremaster, the abdomen bluntly rounded with a ring of elongate punctures.

These structures indicate an affinity with the Nycteolidæ.

DIACRISIA SUBCARNEA Walker.

HARAKA-SHIRO-GA.

Food plant: *Morus alba*.

The larva is a large hairy Arctian of the shape of the North American *Estigmene aceræa* Drury, lightly colored as in pale specimens of *Diacrisia virginica* Fabricius. The head, thoracic feet and abdominal leg plates are black. Body immaculate, except for broken mottled dark subdorsal and substigmatal stripes.

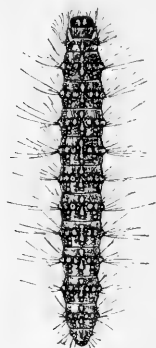


FIG. 6.—DIACRISIA IMPARILIS, LARVA.

DIACRISIA IMPARILIS Butler.

KUWA-KEMUSHI.

Food plant: *Morus alba*.

The eggs are laid in a patch covered by the brownish wool from the abdomen of the female moth.

The larvæ resemble those of *Arsilonche albovenosa* in color, being black with yellow spots and red warts. The hairs are black and white, rather thin and do not obscure the body coloration. Head rounded, bilobed, flat before, shining black, paraclypeus reddish, epistoma and bases of antennæ white. Body cylindrical, normal, with large, elevated, bright-red warts. Wart i small, ii, iii, and v large, iv absent, vi large, black, base of leg broadly hairy. On

the thorax, two warts above the stigmatal wart, normal. Cervical shield densely hairy. Black; a dorsal yellow line, broken into two spots on each segment; fine yellow dottings to a narrow broken subdorsal line; sides more heavily dotted to a waved broken substigmatal line. Feet reddish with black shields.

The cocoon is composed of hair and thin silk. The pupa has the usual Arctian shape.

Family NOCTUIDÆ.

APATELA MAJOR Bremer.

KUWA-NO-SHIRO-KEMUSHI.

Food plant: *Morus alba*.

The larva before me has unfortunately been nearly deprived of hairs, yet a few points may be noted. Head shining black, quadrate bilobed, epistoma and bases of antennæ pale. Body cylindrical, uniform, densely covered with secondary hairs, the warts all obscure and reduced. Pale yellowish, a broad black dorsal band, widened diamond-shape on the segments, forming distinct diamonds on joints 5, 7, 8-9, and 12. Spiracles black, with dark dots, forming a stigmatal line, below which is a diffuse whitish band. Hairs whitish yellow and black, the black apparently tufted subdorsally on the black diamonds, but no pencils. Yellow tufted hairs dorsally on joints 6, 10, and 11; lateral hairs longer, pale. A good specimen would be of interest.

MAMESTRA BRASSICÆ Linnæus.

ENDO-NO-KIRIMUSHI.

Food plant: *Pisum sativum*.

An egg mass, two green young larvæ, two black mature larvæ, and a pupa are preserved. The species is well known and common in Europe.

LEUCANIA UNIPUNCTA Haworth.

AWA-NO-YOTOMUSHI.

Food plant: *Setaria italica*, var. *germanica*.

The well-known "army worm."

HELIOTHIS ARMIGERA Hübner.

TABAKO-NO-AOMUSHI.

Food plant: *Nicotiana tabacum*.

The well-known "boll worm" of the United States.

PLUSIA FESTUCÆ Linnæus.

INE-NO-O-AOMUSHI.

Food plant: *Oryza sativa*.

The larvæ are paler than European specimens, being entirely green, with a white substigmatal stripe, without the black shadings shown in Hofmann's figure.^a

PLUSIA CHRYSITINA Martyn.

TSUMAKIN-GA.

Food plant: *Daucus carota*.

Hampson briefly describes the larva.^b The description applies to the young larva before me, but in the mature ones the markings are modified.

The head is green with a heavy black band on the posterior side from mouth nearly to vertex. Body robust, more slender before, abdominal feet on joints 9, 10, and 13. Green, a geminate, waved, linear dorsal line; traces of a subdorsal line and a narrow broken suprastigmatal one. Tubercle iii black, the rest white. A small black anal plate; cervical shield green. Setæ coarse, white, normal. Skin all finely pilose from the produced skin spines.



FIG. 7.—PLUSIA CHRYSITINA, LARVA.

Cocoon a thin white web. Pupa black with brown incisures, a rounded prominence at the end of the wing cases; cremaster hooked.

NARANGA DIFFUSA Walker.

INE-NO-AOMUSHI.

Food plant: *Oryza sativa*.

The eggs are shown laid in straight rows of four or five on a rice blade, the larvæ are mounted on young rice plants about four inches high, and the pupa is folded up in a blade.

The larvæ are slender, green, without marks, the tubercles small and concolorous, normal. The feet of joints 7 and 8 are small, the rest well developed.

Hampson's figure of the adult is misleading, as it appears to represent a dark moth with pale bands,^c whereas the species is really pale with dark bands.

^a Gros Schmett. Eur., pl. xxxv, fig. 10.

^b Moths of India, II, 1891, p. 573.

^c Idem, II, 1894, p. 333.

Family NYCTEOLIDÆ.

EARIAS CHROMATARIA Walker.

WATA-NO-RINMUSHI.

Food plant: *Gossypium herbaceum*.

If at all abundant, this must be a serious pest for cotton. The young larva is mounted between bracts, the mature one within a boll, the contents of which it has destroyed; another is placed upon a flower.

Head rounded, bilobed, small, withdrawn into joint 2, black, purple on the lobes, reddish on the sides, sutures of clypeus very broadly whitish, clypeus black in the center. Body robust, thick, uniform, with two rows of ciliated papillæ corresponding to tubercles ii and iv; other tubercles small with long single setæ.

Purplish brown, a white subgeminant dorsal band, widened on joints 7-8 and 9-11. Tubercles of joints 2 to 4 broadly ringed with orange; orange spots subdorsally and substigmatally on the abdominal segments. Spiracles black; feet normal; subdorsal papillæ of joints 3, 4, 6, 9, 12 black, the rest white.

Cocoon of white silk with vertical slit for emergence as usual in the family. Pupa without cremaster.



FIG. 8.—EARIAS CHROMATARIA, LARVA.

Family NOTODONTIDÆ.

PHALERA FLAVESCENS Bremer and Grey.

SAKURA-KEMUSHI.

Food plants: *Pyrus malus*.

Eggs laid in a patch. Shape of two-thirds of a sphere, white and smooth, slightly shagreened; a circular clearer vertical area; diameter, 0.7 mm.

The larva has the structure of the North American genus *Datana*. The young larva (stage iv) is dark-wine red, head, shields, thoracic feet and spiracles black. Traces of longitudinal pale lines on the sides, a subdorsal and a lateral visible. Tubercles black; i, rather large; ii, small; iii, iv, and v, small; iv, behind the spiracle, normal. Hair short, white, nearly lost in the numerous short secondary ones, which are thick subventrally, and obscure tubercle vi. In the last stage the larva is entirely black with scarcely a trace of lines (the subdorsal showing faintly intersegmentally). Hair secondary, the primary tubercles indistinguishable, short, white, tufted subdorsally on the segments. A few long ones, especially anteriorly and subventrally. Head elliptical, higher than wide, slightly bilobed, black, shagreened, with many white hairs.

The pupa is mahogany brown, as in *Datana*, the cremaster with short spines, in two groups.



FIG. 9.—PHALERA FLAVESCENS, LARVA.

Family LIPARIDÆ.

PORTHETRIA DISPAR Linnæus, var. JAPONICA Motschulsky.

HANNOKI-KEMUSHI.

Food plant: *Alnus maritima*.

This has been called the same as the European *dispar* Linnaeus,^a but the moths are twice the size and the female more dusky colored. I should call it a good geographical race at least. Swinhoe lists it as a distinct species.^b The egg mass, larva, and pupa are preserved, all as in *dispar*, but proportionately larger.

EUPROCTIS CONSPERSA Butler.

CHA-KEMUSHI.



FIG. 10.—EUPROCTIS CONSPERSA, LARVA.

Food plant: *Thea chinensis*.

The larvæ are apparently gregarious. Head rounded, pale reddish, immaculate. Body cylindrical, robust, tapering a little on the thorax. Tubercles small, flattened, with weak, but numerous, hairs, longer subventrally. On joints 5 to 12 a circular subdorsal area involving warts i and ii is slightly raised and tufted with hairs. The areas become confluent on joints 5 and 6, but are smaller and separate posteriorly. Dorsal eversible glands of joints 10 and 11 weak, and not contrastingly colored. Dorsum reddish; a broad black subdorsal band separated by a narrow yellowish line from a black lateral one about half the width of the subdorsal. Sides and subventer pale. Subdorsal areas black, weakly tufted with short hairs, which do not form tussocks. Subdorsal wart of joint 2 subpapillose.

PORTHESIA SIMILIS Fuessly, var. XANTHOCAMPA, new variety.

KIN-KEMUSHI.

Food plant: *Morus alba*.

The larva differs strikingly in coloration from its European representative, though it has the same structure and pattern. The subdorsal tubercles of joint 2, subventral ones (tubercle v), and a patch on joint 13 are bright red, but the other markings are yellow. Instead of the double narrow red dorsal line of the European larva there is a broad yellow band covering the whole dorsum to tubercle ii, single, or divided by a reddish dorsal line. The semicircle about the tuft on



FIG. 11.—PORTHESIA XANTHOCAMPA, LARVA.

^aLeech, Trans. Ent. Soc. Lond., 1899, p. 130.

^bTrans. Ent. Soc. Lond., 1903, p. 483.

joint 5 is yellow; sides overspread with yellow; a narrow suprastigmatal and broad substigmatal band partly confluent. Hairs as in the western form.

Type.—Cat. No. 8395, U.S.N.M.

Family LASIOCAMPIDÆ.

MALACOSOMA NEUSTRIA Linnæus, var. **TESTACEA** Motschulsky.

UME-KEMUSHI.

Food plant: *Prunus mume*.

The larvæ differs distinctly from the European one, so that I think a racial name is justified, although Leech sinks *testacea* as a synonym.^a The dorsal stripe is blue (not white), of the color of the lateral shadings, while the lower of the orange subdorsal lines is entirely absent. It much resembles the North American *M. fragilis* Stretch, but the addorsal orange line is straight and concrete, not diffused and mottled.

DENDROLIMUS PINI Linnæus.

MATSU-KEMUSHI.

Food plant: *Pinus densiflora*.

The larvæ before me are in several stages, but none fully grown. They differ from my European specimens in lacking the pale dorsal mottlings which form blotches on the abdomen. These larvæ are uniformly darkly colored.

Family BOMBYCIDÆ.

BOMBYX MANDARINUS Moore.

KUWAGO.

Food plant: *Morus alba*.

Leech states that this is probably the wild form of the cultivated silkworm, *Bombyx mori* Linnæus.^b Both adults and larvæ are much darker in color than the cultivated form.

Family GEOMETRIDÆ.

CISTIDIA COUAGGARIA Guenée.

UME-SHAKUTORI-MUSHI.

Food plant: *Prunus mume*.

The larva has a black head, with a transverse yellow line across the clypeus and a narrow, short, vertical one on the apex of each lobe.

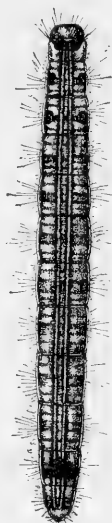


FIG. 12.—MALACOSOMA TESTACEA, LARVA.

^a Trans. Ent. Soc. Lond., 1899, p. 111.

^b Idem., 1898, p. 271.

Body stout, normal; a small pair of functionless feet on joint 8 and a still smaller one on joint 7. Color black and orange. Ground color black; dorsal, subdorsal, lateral, and substigmatal yellow lines, broken into dots, the lateral one nearly all lost, joined by yellow bands on the posterior edges of the segments. A few yellow dots subventrally and on the leg bases. Yellow color extensive in the thoracic incisures. Skin smooth, but numerous annulate; tubercles and setæ minute.

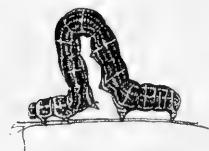


FIG. 13.—*CISTIDIA COUAGGARIA*, LARVA.

The pupa is shown in an open hammock of threads. It is pale, striped and banded with black.

This species was described as *Balthia eurymede* by Motschulsky, placed in the genus *Vithora* by Leech^a and in *Cistidia* by Swinhoe^b Guenée's specific name *couaggaria* is the oldest.

PHTHONANDRIA ATRILINEATA Butler.

EDA-SHAKUTORI-MUSHI.

Food plant: *Morus alba*.

The eggs are distributed on the back of a leaf.

The larva resembles a twig in shape, as the Japanese name implies. Head rounded, slightly bilobed, brown. Thoracic feet large, black lined. Body robust, joint 9 collared dorsally; tubercles ii of joints 5 and 9 elevated, white. Mottled red-brown, blackish, and white without defined pattern. An irregular pale dorsal and subdorsal line and white blotches on joints 5, 8, and 9. A divided black bar before the collar on joint 9 with three white dots below tubercle ii. Pupa in a thin cocoon.

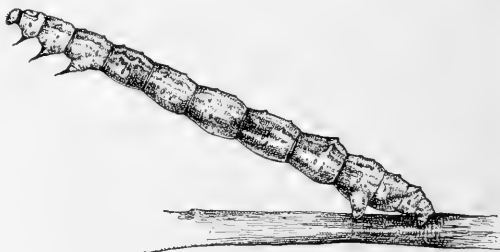


FIG. 14.—*PHTHONANDRIA ATRILINEATA*, LARVA.

PHTHONOSEMA TENDINOSARIA Bremer.

CHA-NO'SHIMOFURI-SHAKUTORI-MUSHI.

Food plant: *Thea chinensis*.

The larva has the head flat before, bilobed, brown with numerous angular black dots. Body robust, uniform, wood brown, annulate, covered with numerous minute black or brown rings, most of which contain white central dots. At the posterior end of joints 5 and 6 are white raised elliptical spots like Tachinid eggs. These are repeated

^aAnn. Mag. Nat. Hist. (6), XIX, 1897, p. 459.

^bCat. Lep. Oxf., II, 1900, p. 307.

on joints 6 to 10, but less extensively, being dorsal only and smaller. Tubercles i of joint 12 approximate, elevated, pointed. A black shade about the spiracle on joint 5. Feet normal, concolorous, black lined.

I have been unable to consult the original figure^a and there exists no subsequent description; consequently the identification is in some doubt. Mr. Nawa's name, *Opthalmodes cretacea* Butler, is obviously



FIG. 15.—PHTHONOSEMA TENDINOSARIA, LARVA.

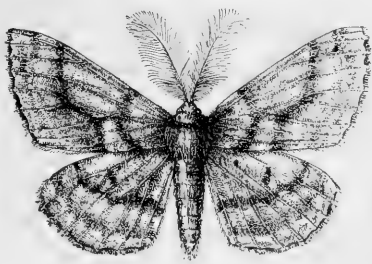


FIG. 16.—PHTHONOSEMA TENDINOSARIA, ADULT.

incorrect, since this is synonymous with the European *Ascotis selennaria* Schifferrmüller.^b

ACANTHOCAMPA, new genus.

Male antennae lengthily bipectinate, the pectinations decumbent; of female simple. Palpi not exceeding the frontal hairs, porrect, hairy below. Front with a large, three-sided prominence above, pointed and slightly ridged on the angles, largely covered by the vestiture. A tuft of scales on vertex of head; thorax densely hairy; abdomen smooth, short, robust. Legs with long hair posteriorly; hind tibiae with four spurs, not swollen. In the fore-wing vein 2 before angle of cell, 3-4 stalked, 5 above the middle of the very broad cell, 6 below apex, 7 out of 8, 8 out of 9 near apex, 10 absent, probably coincident with 11; wing long and narrow, costa slightly concave, outer margin convex, very oblique, a little crenulate. Hind



FIG. 17.—ACANTHOCAMPA EXCAVATA, LARVA.



FIG. 18.—ACANTHOCAMPA EXCAVATA, ADULT.

wings with vein 2 before the angle of the cell, 3-4 stalked, 5 absent but with a slight projection on the margin, 6-7 long stalked, 8 very strong, running close to 7, ending in the costa soon after end of cell; wing narrow, costa concave in both sexes, outer margin long, convex, crenulate, the most distinct projection at end of vein 6.

^a Bremer, Lep. Ost.-Sib., 1864, p. 73, pl. VII, fig. 17.

^b Swinhoe, Cat. Lep. Oxf., II, 1900, p. 289.

ACANTHOCAMPA EXCAVATA, new species.

TOGE-SHAKUTORI-MUSHI.

Food plant: *Morus alba*.

Head white with vertical tuft brown, thorax gray brown. Wings grayish white overspread with fuscous on the margins and on base of inner margin of fore wings to outer line, with scattered brown irroration. Lines broad, black and brown, both bent in on median vein. A subterminal shade joins the fuscous margin to costa before apex. Hind wing with a broad central band. The fuscous shading is somewhat more extensive and continuous in the male; otherwise the sexes are alike in coloration. Expanse: male, 45 mm., female 55 mm.

This is probably *Zamaca albofasciaria* Leech,^a but I have been unable to consult the original description. The new genus seems justified in any case, as this species differs from *Zamaca* in having four spurs on the hind tibiae, equally developed. I prefer, therefore, to found it on a definite species, even if it prove to be a synonym.

The peculiar larva has long prominences like thorns, as indicated in the Japanese name. In the position of repelling attack, in which one larva is mounted, the head is curved beneath the body and the dorsal thorns project prominently. Body robust, feet normal. Head rather small, dark brown. A small dorsal elevation, carrying tubercles i on joint 5; on joints 6, 7, and 8 a high thorn-shaped papilla. Two slender papillae (tubercle ii) on joint 12. A series of small-pointed subventral papillae on joints 5 to 9. Green, a broad brown dorsal area on joints 2-4 and 9-13, broken, except for slight mottlings, on joints 5 to 8 in the region of the dorsal thorns, edged with white, which becomes white streaks on the bases of the thorns. Traces of a subdorsal pale line; spiracles white, black ringed; thorns dark tipped.

Pupa in an earthen cell.

Type.—Cat. No. 8396, U.S.N.M.

Family COCHLIDIIDÆ.

CNIDOCAMPA^b FLAVESCENS Walker.

IRA-MUSHI.

Food plant: *Diospyros kaki*.

The larva has the general structure of *Miresa*, long subdorsal horns at the extremities, covered with stinging spines and a bright color-

^a Ann. Mag. Nat. Hist., (6) XIX, 1897, p. 322.

^b A new name for *Monema* Walker (1855), not Greville (1829). Staudinger pointed out that this name was preoccupied (Rom. Mem., VI, 1892, p. 301), but did not propose a substitute, as he thought the species referable to *Miresa*. It is, no doubt, derived from *Miresa*, but the pectinations of the male antennae have entirely disappeared and I regard it as a distinct generic type.

tion. The larva is allied also to *Natada*, as I do not detect either caltrops spines or the detachable terminal ones of *Euclea*, but it is not a degenerate form like the North American *Natada nasoni*, since the spines are well developed and the coloration of a warning character rather than adapted for concealment.

Horns of subdorsal row short on joints 3, 12, and 13, longer on 4, very long on 5 and 11, minute on 6 and 10, small on 7 to 9, all spined. Side horns short on joint 3, rather long on 4, absent on 5, with the spiracle moved up, moderate on 6 to 12. Skin subgranular shagreened. The color is partially destroyed in the inflated specimens. Graeser briefly describes it from larvæ which he saw at Chabarofka and Blagoweschtschensk, in Amurland, as "dark green, with a shield-shaped marking covering most of the back of dark red-brown." Interpreting my larvæ by this, they are as follows: Purplish brown dorsally, including a diffuse white dorsal band with dark edges, distinct only centrally. Sides green, just covering the lateral horns of joint 4, reaching up to the subdorsal horns on joints 7 to 9, retreating to the lateral horn on joint 11, but covering joints 12 and 13, and in an angular patch about



FIG. 19.—CNIDOCAMPA FLAVESCENS, LARVA.

the subdorsal horns of joint 11; green spots below the subdorsal horns of joints 4 and 5. A white broken lateral band with dark edges; subventral edge pale, with a dark line above. The depressed spaces are but little developed and not distinguishable in the specimens.



FIG. 20.—CNIDOCAMPA FLAVESCENS, COCOONS.

The cocoon is spun on the twigs of the food plant. It is elliptical, usually white, with strangely shaped broad brown streaks, looking, as Pryer says, like a bird's egg. Some of the cocoons are evenly mixed white and brown. They are firmly attached to the twig, and will often break before they can be detached. Like other Cochlidiæ, it has a variety of food plants, any smooth-leaved tree being acceptable.

Under these conditions it is a species most easily imported. I have had specimens from San Francisco, California, brought on young trees from Japan. There is also reported the importation of what was evidently this species to Hamburg, Germany,^a but the species has never become acclimated anywhere that I know of.

^a Kraepelin, Mitth. a. d. Naturhist. Mus. Hamburg, XVIII, 1901, p. 196.

Family PSYCHIDÆ.

CLANIA MINUSCULA Butler.

MINO-MUSHI.

Food plant: *Thea chinensis*.

The bags are shown in various stages, a fully grown larva and the male pupa. The bags and larvæ are so similar to the North American *Thyridopteryx ephemæformis* that a separate description is unnecessary.

Family ZYGAENIDÆ.

ILLIBERIS PRUNI, new species.

HOSHI-HAMAKI-KEMUSHI.

This species was named by Doctor Holland "*Procris nigra* Leech," and Mr. Nawa had the same identification. It is certainly incorrect, as Leech says of *Procris nigra* "female antennæ simple," whereas in the specimens before me they are pectinated in both sexes.



FIG. 21.—ILLIBERIS
PRUNI, LARVA.

The specimens agree with Leech's figure of *Northia dirce*, except that there is no black apex to fore wing; they disagree with Butler's figure of *Northia tenuis* in having the abdomen blackish without green tint. I have sixteen specimens without trace of green. They agree partly with *Illiberis consimilis* Leech which is said to be closely allied to *tenuis*, but the costal area of hind wings not blackish. It is, however, blackish in my specimens. Besides these, Leech mentions from Japan *sinensis* Walker, *nigra* Leech and *psychina* Oberth., but I can not reconcile the descriptions with my specimens. Of course this form has been received from Japan before, but it must have been referred wrongly, if the descriptions are to be relied upon.

Wings hyaline, veins and margin narrowly black, costal and internal areas of fore wings and costal area of hind wings black shaded. Antennæ greenish; thorax and abdomen brown black.

Food plant: *Pyrus communis*.

The larva has the structure of the European species of *Adscita*, the warts low and flattened, with short hairs only. Dorsum pale (green?), subventral region reddish, warts concolorous. A black dorsal band, widened on the segments and a subdorsal round spot on each segment below the subdorsal wart. Head marked with black; cervical shield black dusted.

The cocoon is of white silk and spun among leaves.

Type.—Cat. No. 8397, U.S.N.M.

BINTHA CHINENSIS Felder.

TAKE-KEMUSHI.

Leech^a puts this species in *Aræocera*, but incorrectly, as that genus has the male antennæ simple while they are pectinated in the present species. The specimens are labeled "*Procris funeralis*" and perhaps really are that species, i. e. *Adscita funeralis* Butler; but Butler's description, though very short, disagrees with the specimens before me. The abdomen is said to be black, the claspers and proboscis horn yellow, while in the form before me the body is leaden bluish as described by Felder, the tongue seems concolorous, and the claspers are entirely concealed. I place the species in *Bintha*, although the palpi are rather short, not exceeding the front, and there are no spots on the wings.

Food plant: *Arundinaria japonica*.

The larva resembles the preceding, but is more elongate and has long hair from the terminal and lateral warts. Pale dorsally, brown subventrally, the warts black, those of joints 3, 4, 12, and 13 enlarged and distinctly black.

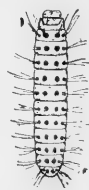


FIG. 22.—BINTHA CHINENSIS, LARVA.

Family PYRALIDÆ.

MARGARONIA PYLOALIS Walker.

KUWA-HAMAKI-MUSHI.

Food plant: *Morus alba*.

Nearly allied to the North American *M. sibillalis* Walker, and with the same food habit. It webs up the leaves of mulberry. Head brown, body green with the small tubercles black. An addorsal and a stigmatal whitish line.

PYRAUSTA POLYGONI, new species.

AI-NO-MUSHI.

The moth looks very much like *P. nubilalis* Hübner, and has probably been confused with it. *P. nubilalis* occurs in Japan. I have a specimen from Professor Matsumura labeled "Stalk borer, injurious to *Panicum* family," which shows that the larva has a different food habit. The present species has the dark streak at base of vein 1 of fore wing, characteristic of the subgenus *Micratis* Warren. The wings are not quite as pointed as in *nubilalis* and veins 4 and 5 of hind wings are farther spaced at origin. The sexes are colored alike, the lines as in the female *nubilalis*, but the outer line is softer and less

^aTrans. Ent. Soc. Lond., 1898, p. 332.

dentate; the subterminal band is a smooth shade only, not visibly dentate. On the hind wings the median shade is more outwardly placed and more dentate, most produced at vein 2; subterminal line close to the margin, rather distinctly dentate in the female specimen before me, more clouded in the male.



FIG. 23.—PYRAUSTA POLY-
GONI, ADULT.

Food plant: *Polygonum tinctorium*.

The larva is shown within a swelling in the stem of the food plant, which is cut off, with a hole at the top. Head marked with brown, the body colorless with rather large pale tubercles.

Type.—Cat. No. 8398, U.S.N.M.

CHILO SIMPLEX Butler.

INE-NO-ZUIMUSHI.

Food plant: *Oryza sativa*.

The larva is shown within the rice stem. It is pale, with subdorsal and lateral purplish bands, the tubercles small, black centered, obscure. Head brown.

Family TORTRICIDÆ.

EXARTEMA MORI Matsumura.

AO-HAMAKI-MUSHI.

Food plant: *Morus alba*.

The larva is shown on the leaves of mulberry. The head is black, shining, the body entirely immaculate, probably green.

EXARTEMA MORIVORA Matsumura.

SHIN-MUSHI.

Food plant: *Morus alba*.

The larva is shown on the very young leaves of mulberry. Head shining black, cordate; cervical shield large, shining brown-black; tubercles small, but decidedly brown-black, the body otherwise pale (green?). Anal plate dark. The larva is about half the size of the preceding species.

Professor Matsumura described this species as *Sericoris morivora*;^a but it seems to me more properly referred to *Ecartema*, as the dorsal lobe of hind wing is fully as long as in the preceding species. Lord Walsingham^b calls attention to the presence of the dorsal lobe in a rudimentary state in *Olethreutes* (= *Sericoris*); but this is well developed.

^a Ent. Nachr., XXVI, 1900, p. 195.

^b Ann. Mag. Nat. Hist. (7), VI, 1900, p. 28.

ADDITIONS TO THE RECORDED HYMENOPTEROUS FAUNA
OF THE PHILIPPINE ISLANDS, WITH DESCRIPTIONS OF
NEW SPECIES.

By WILLIAM H. ASHMEAD,
Assistant Curator, Division of Insects.

In my previous papers on the Hymenopterous fauna of the Philippine Islands, I find that I overlooked many species recorded from the archipelago. Below, therefore, I give a list of these omissions and follow with descriptions of two new genera and twenty-eight new species received recently from Father Robert Brown, S. J., of the Philippine Weather Bureau, Manila, Prof. Charles S. Banks, of the Government Laboratories, Manila, and Dr. E. A. Mearns, U. S. A.

Family APIDÆ.

TRIGONA BIROI Friese.

Trigone biroï FRIESE, Termes Füzetek, XXI, 1898, p. 42, female.

This is the only stingless honeybee recorded from the islands, although several are known from India. Undoubtedly other species will be found.

Family NOMADIDÆ.

NOMADA PHILIPPINENSIS Vachal.

NOMIA DIMIDIATA Vachal.^a

Family XYLOCOPIDÆ.

The following carpenter bees were described by Mr. J. Pérez:^b (1) *Xylocopa fuliginosa* Pérez, female, p. 41, Mindanao, (2) *X. amauroptera* Pérez, female, Palauan, (3) *X. sulcifrons* Pérez, female, Palauan, (4) *X. vachali* Pérez, male, Palauan, (5) *X. euchlora* Pérez, male, Palauan, (6) *X. adusta* Pérez, female, Mindanao, and (7) *X. occipitalis* Pérez, Mindanao.

^a Miscell. Entom., V, 1897, p. 8.

^b Actes de la Société Linnéenne de Bordeaux, LVI, 1901.

Family MEGACHILIDÆ.

Ctenoplectra vagans COCKERELL, Ann. and Mag. Nat. Hist., (7) XIV, 1904, p. 204, male.

Superfamily Formicoidea.

An important paper by Prof. C. Emery,^a treating of the ants from the island of Luzon, was overlooked by me. He gives a list of the species and describes some new varieties and species. Here they are: (1) *Diacamma geometricum*, var. *viridipurpureum*, Emery, female, Antipolo; (2) *Odontoponera transversus* Smith, female, Antipolo; (3) *Poneroluteipes* Mayr, female, Antipolo; *Ponera*, sp.? (4) *Odontomachus hæmatodes* Linnaeus, female, Manila; (5) *O. infandus* Smith, female, Antipolo; (6) *O. papuanus* Emery, var. Manila; (7) *Bothroponera glabripes* Emery, female, Mindanao; (8) *Sima alloborans* Walker, Manila, Antipolo; (9) *Monomorium destructor* Jerdon, female, Manila, Antipolo; (10) *Cremastogaster ochracea* Mayr, female, Antipolo; (11) *C. simoni* Emery, female, Manila, Antipolo; (12) *C. semperi* Emery, female, Manila; (13) *C. longiclavata* Emery, female, Antipolo; (14) *C. crassicornis* Emery, female, Manila; (15) *C. bicolor* Mayr, subsp. *imbellis* Emery, female, Manila; (16) *Pheidologeton pygmaeus* Emery, var. *albipes* Emery, female, Antipolo; (17) *Solenopsis geminata* Fabricius, female, Manila, Antipolo; (18) *Pheidole simoni* Emery, (soldier), Manila; (19) *P.* sp., female, Antipolo; (20) *Tetramorium pacificum* Mayr, subsp. *subscabrum* Emery, female, Antipolo; (21) *Dolichoderus tuberculatus* Mayr, female, Manila, Antipolo, Quruña; (22) *Tapinoma melanocephalum* Fabricius, female, Manila, Antipolo; (23) *Technomyrmex albipes* Smith, female, Manila; (24) *Plagiolepis longipes* Jerdon, female, Antipolo; (25) *Ecophylla smaragdina* Fabricius var. *subnitida* Emery, female, Antipolo; (26) *Prenlepis*, sp., female, Antipolo; (27) *Camponotus pallidus* Smith, female, Manila; (28) *C.* sp., female, Antipolo; (29) *C.* (*Colobopsis*) *pubescens* Mayr, female, Manila; (30) *C. quadrisectus* Smith, female, Mindanao; (31) *C. platypus* Roger, female, Mindanao; (32) *C. nigricans* Roger, female, Jolo; (33) *C. pennsylvanicus* var. *japonicus* Mayr, female, Mindanao; (34) *C. n.* sp., female, Mindanao; (35) *Polyrhachis trinax* Roger, subsp. *saigonensis* Forel, female, Manila, Antipolo; (36) *P. thrinax* subsp. *javana* Mayr, female, Quruña; (37) *P. bihamata* Drury, female, Antipolo; (38) *P. pubescens* Mayr, female, Antipolo; (39) *P. bicolor* Smith, female, Antipolo; (40) *P. direx* Smith, female, Manila; (41) *P. argentea* Mayr, female, Manila, Antipolo.

^aAnn. Soc. Ent. France, LXII, 1893, p. 261 et seq.

DESCRIPTIONS OF NEW SPECIES.

Family BOMBIDÆ.

Genus BOMBUS Latreille.

1. BOMBUS MEARNSI, new species.

Female.—Length 9 mm. Black, clothed with a long, grayish pubescence, that on the abdomen more or less yellowish, mixed with some black hairs, that on the tibiæ and tarsi ferruginous; ventral segments at apex narrowly testaceous; all tarsi and the middle and hind tibiæ ferruginous; claws black and cleft. The head is smooth and shining, but sparsely and minutely punctured on the face; the malar space is distinct, fully as long as wide; the first joint of the flagellum is about as long as joints 2 and 3 united, while the second joint is only a little longer than thick and much shorter than the third. Wings hyaline, with the stigma, costal and median veins blackish, the other veins flavo-testaceous.

Type.—Cat. No. 8323, U.S.N.M.

Mindanao. This species is described from a single specimen taken by Dr. E. A. Mearns on Mount Apo, at an altitude of 6,000 feet. It is the first species to be described from the Philippines, and is named in honor of its discoverer.

Family PROSOPIDIDÆ.

Genus PROSOPIS Fabricius.

2. PROSOPIS TAGALA, new species.

Female.—Length 6 mm. Black, the head and thorax finely, closely punctate, the triangular area on metanotum rugulose, the abdomen smooth and shining, impunctate; the triangular lateral plates on each side of the clypeus, a stripe on each side of the upper margin of the prothorax, the prothoracic tubercle, a small spot on the tegulae anteriorly, and the tibial spurs are white, rest of legs black, but the sutures of the tarsal joints and beneath are more or less ferruginous or brownish. Wings hyaline, the stigma and veins dark brown, the former being nearly black; the first and second recurrent nervures are, respectively, interstitial with the first and second transverse cubital nervures, the second cubital cell being quadrate, or very nearly.

Type.—Cat. No. 8200, U.S.N.M.

Manila. Described from a single specimen received from Mr. Charles S. Banks, of the Bureau of Government Laboratories.

Family OXYBELIDÆ.

Genus NOTOGLOSSA Dahlbom.

3. NOTOGLOSSA BANKSI, new species.

Female.—Length, 4 mm. Opaque, black, closely, confluent punctured, the face below the antennæ and the sternum clothed with sparse, silvery-white hairs; the clypeus has a median ridge and is slightly emarginate anteriorly; the mandibles are testaceous; the prothoracic tubercles, the tegulæ, a spot on front femora beneath toward apex, the apex of the middle femora, a broad annulus at the base of the hind tibiæ, and all the other tibiæ and tarsi are yellowish-white; the scales on each side of the scutellum and the apical margins of the emarginate scale at its apex are also white or yellowish-white; the abdomen is black, but there is an oblong white spot on each lateral apical margin of the first and second segments. Wings hyaline, the stigma and veins brown.

Type.—Cat. No. 8201, U.S.N.M.

Manila. This species closely resembles the North American species *N. emarginata* Say, but the prothoracic tubercles in that species are not white and the emarginated scale at the apex of the scutellum is shorter, more deeply emarginate, and quite different in shape.

Only a single specimen is known and was sent me by Mr. Charles S. Banks, in honor of whom the species is named.

Family LARRIDÆ.

Genus PISON Spinola.

4. PISON PUNCTULATUS, new species.

Male.—Length 7 mm. Black and shining, the forehead and the thorax finely, microscopically punctulate, and clothed with a silvery pubescence, the metathorax striated, the striæ on the metanotum oblique, the basal area not defined, the median sulcus only slightly indicated, with a delicate carina basally; the median sulcus on the truncature is well defined; legs, including tibial spurs, entirely black; the abdomen is black and impunctate, with a faint silvery pubescence at the sides and at the apex of the segments, very distinct in certain lights, but absent on the pygidium and the two preceding segments. Wings hyaline, faintly tinted at apex, the stigma and veins black; the second cubital cell is longly petiolated and receives the first recurrent nervure very near its basal angle; the second recurrent nervure is interstitial or nearly with the second transverse cubitus.

Type.—Cat. No. 8338, U.S.N.M.

Manila. (Father Robert Brown.)

Allied to *P. lagunæ* Ashmead, but quite distinct in punctuation and in metathoracic differences.

Genus PISONOIDES Smith.

5. PISONOIDES BROWNI, new species.

Male.—Length 6 mm. Black and shining, nearly smooth, and clothed with a silvery white pubescence, the clypeus with a slight triangular process anteriorly, the mesonotum with two short, grooved lines near the lateral middle, the metathorax with a crenate-grooved line down the middle and a grooved line on its oblique apical truncature, the truncature being transversely striated, the metanotum being smooth; the tegulae, the subcostal vein, all knees, the front tibiae and tarsi, the titial spurs, extreme apex of middle tibiae, the apices of the joints of the middle tarsi, and the last joint of the hind tarsi are yellowish; the abdomen is shining, but distinctly, minutely punctulate, the outer margins and the apices of the segments *laterally* being clothed with a fine, silvery pubescence. Wings hyaline, the stigma and veins, except the subcostal vein, black; there are only *two* cubital cells; the second recurrent nervure is nearly interstitial with the first transverse cubitus, the first recurrent joins the second cubital cell at its lower hind angle.

Type.—Cat. No. 8332, U.S.N.M.

Manila. (Father Robert Brown.)

Pisonoides is a good genus and to it belong the Indian species placed in *Pison* by Colonel Bingham, under his section B, namely: *P. erythropus* Kohl, *P. agile* Smith, *P. rothneyi* Cameron, and *P. obliteratum* Smith, the last mentioned being the type of the genus.

Family TRYPOXYLIDÆ.

Genus TRYPOXYLON Latreille.

6. TRYPOXYLON ELONGATUM, new species.

Female.—Length 16.5 to 17 mm. Very elongate, black and shining; the mandibles, flagellum beneath, a spot at base of all tibiae, the extreme base and apex of the second dorsal abdominal segment, the lateral margins of the same broadly, and the base and lateral margins of the third dorsal abdominal segment, are red; the front and middle tarsi and all tibial spurs are yellowish; the head anteriorly, the clypeus (densely), the temples and the sides of the thorax (sparsely) are clothed with a silvery white pubescence; the very longly petiolated abdomen is fully twice as long as the head and thorax united, the petiole alone being nearly as long as the thorax. Wings hyaline, the stigma and veins black.

Type.—Cat. No. 8334, U.S.N.M.

Manila. (Father Robert Brown.)

Family VESPIDÆ.

The specific name of the *Icaria*^a recently described by me should read *Cagayanensis* instead of *Cayayanensis*. I am indebted to Mr. Charles S. Banks for calling my attention to this typographical error.

Family EUMENIDÆ.

Genus LEIONOTUS Saussurè.

7. LEIONOTUS XANTHOZONATUS, new species.

Female.—Length 9 mm. Black, the head and thorax coarsely punctate, the abdomen impunctate, but microscopically coriaceously sculptured; the clypeus is covered with a short yellowish-white pubescence; there is an oblique oblong spot on each side at base of clypeus, a small spot in the incision of the eyes, a stripe back of eyes, two nearly confluent spots on the upper middle of the pronotum, a spot at base and apex of the tegulæ, a spot on the hind angle of the mesonotum next to the tegulæ, a spot beneath the tegulæ, the post-scutellum, the apical margins of the first and second dorsal segments of the abdomen, a large spot at the apical third of the front and middle femora beneath, and a stripe on the front, middle, and hind tibiæ outwardly, all yellow; wings smoky hyaline with the stigma and veins black. The first joint of the flagellum is the longest joint, being nearly one-half longer than the second, the following joints to the last gradually shortening, the four joints before the last being a little wider than long.

Type.—Cat. No. 8335, U.S.N.M.

Manila. (Father Robert Brown.)

Family MUTILLIDÆ.

Genus TROGASPIDIA Ashmead.

8. TROGASPIDIA BICOLOR, new species.

Male.—Length, 17 to 19 mm. Head, thorax, legs, and the first and last two segments of the abdomen black; the rest of the abdomen is red; the head and the thorax are rugosely punctured; the scutellum has a smooth, conically elevation at apex above; the metanotum has a broad, smooth, median sulcus, which is broadly widened out at its base; the face, cheeks, legs, and the mesopleura are clothed with rather long, somewhat dense, white hairs, almost silvery beneath the eyes; the clypeus is smooth and shining, broadly and shallowly or subsemicircularly emarginate anteriorly; the scape is bicarinate beneath; the wings are brown black, with a purplish tinge, the tegulæ being large and smooth, with only a few scattered punctures; the first segment of the abdomen is rather strongly, closely punctured, has a large tooth

^a Can. Ent., XXXV, 1905, p. 3.

beneath, and is clothed with long, sparse, whitish hairs; the other segments are smooth and shining, although with some sparse punctures, the two apical segments being black and clothed with black hairs.

Type.—Cat. No. 8202, U.S.N.M.

Manila. Described from five specimens received from Mr. Charles S. Banks.

9. *TROGASPIDIA MINOR*, new species.

Male.—Length 12–13 mm. Resembles *T. bicolor* very closely, but is considerably smaller and not so closely sculptured on the head; the abdominal segments 1 to 4 and the base of the fifth are red, the rest black; the median sulcus on the metanotum is not so broadly dilated at its base as in *T. bicolor*, the wings not so dark, and with only the faintest tinge of purple in certain lights.

Type.—Cat. No. 8203, U.S.N.M.

Manila. Described from several specimens taken by Mr. Charles S. Banks. The species is evidently allied to *Mutilla analis* Lepel, described from India.

Family SCELIONIDÆ.

Genus MACROTELEIA Westwood.

10. *MACROTELEIA MANILENSIS*, new species.

Male.—Length 2.2 mm. Black, clothed with a sparse whitish pubescence, the head closely punctured, the thorax more finely punctured, the parapsidal furrows indicated by two punctate lines; the apex of the scutellum has two tufts of long white hairs; the abdomen is opaque, very finely sculptured, but with the extreme apex of the segments shining; the legs, including the coxæ, are pale brownish yellow. The wings are hyaline, but with a faint smoky tinge, the veins being brown-black; the marginal vein is only about half the length of the postmarginal; the stigmal vein is short and delicate, slightly curved, a little shorter than the marginal, and ends in a small knob.

Type.—Cat. No. 8341, U.S.N.M.

Manila. (Father Robert Brown.)

Genus SCELIO Latreille.

11. *SCELIO PHILIPPINENSIS*, new species.

Male.—Length 2.8 mm. Black, the head and thorax umbilicately punctate, the mesonotum with parapsidal furrows, but not sharply defined; the scape of the antennæ, except at apex, the tegulæ, and the legs, except the hind tarsi, which are fuscous, are brownish yellow. The wings are hyaline, the apex of the subcostal vein, the small stigma, and the short poststigmal and stigmal veins are brown-black.

The first joint of the funicle is the longest joint; it is obconical and about thrice as long as thick at apex, or nearly twice as long as the pedicel; the second joint is hardly two-thirds the length of the first; the following six joints constitute the club, the joints of which, except the first and the last, which are longer than thick, are not or hardly longer than wide. The abdomen is longitudinally striated, the striae being very distinct on all the ventral segments.

Type.—Cat. No. 8336, U.S.N.M.

Manila. (Father Robert Brown.)

Family PLATYGASTERIDÆ.

Genus ANOPEDIAS Förster.

12. ANOPEDIAS LUZONICUS, new species.

Female.—Length 0.8 mm. Polished black, impunctate; the antennæ, except the club joints, and the legs, except the coxæ, tips of middle and hind femora, and tips of hind tibiæ, are yellow; the joints of the antennal club and the coxæ are black, while the middle and hind femora toward apex, and the tips of the hind tibiæ, are brownish.

The abdomen is conically pointed, a little longer than the head and thorax united, the basal segment being clothed with a whitish pubescence.

Type.—Cat. No. 8315, U.S.N.M.

Manila. (Father Robert Brown.)

Family CHALCIDIDÆ.

Genus CHALCIS Linnæus.

13. CHALCIS BANKSI, new species.

Male and female.—Length 2.6 to 2.8 mm. Black, the head and thorax closely, opaquely punctate, the metathorax coarsely reticulated, clothed with a sparse whitish pubescence; the tegulæ, the apices of the femora, and the tibiæ, except a black spot on the front and middle tibiæ *beneath*, and a black stripe on the hind tibiæ *beneath*, a narrow black annulus at the base and at the middle of the hind tibiæ, and all the tarsi, except the pulvilli, are white. Wings hyaline, the veins black; the marginal vein is nearly four times as long as the stigmal vein, the latter being only about half the length of the postmarginal. The legs, including the coxæ, are highly polished, impunctate. The abdomen is also highly polished, but dorsal segments 4 to 7 exhibit some fine punctures toward apex.

Type.—Cat. No. 8392, U.S.N.M.

Manila. Described from 3 specimens (Chas. S. Banks). Allied to *C. albotibialis* Ashmead, but is quite distinct in the opaquely punctate head and thorax, and in the color of the legs.

Family EURYTOMIDÆ.

Genus EURYTOMA Illiger.

14. EURYTOMA BANKSI, new species.

Female.—Length 1.6 mm. Stature and general appearance of *E. manilæ*, but differs decidedly in the color of the antennæ and legs. The scape, except at the extreme apex, the trochanters, more or less, the front tibiæ, and the middle and hind knees are honey-yellow; the tips of the middle and hind tibiæ, and all tarsi, are snow-white; the tip of the scape and the rounded pedicel are black; the flagellum is brown-black and pubescent, the first joint the longest, about twice as long as thick, the following joints to the club shortening, the last being scarcely longer than thick.

Male.—Length 1.3 to 1.4 mm. Readily recognized by the structure of the antennæ, or flagellum, and the abdomen. The flagellum is a little more than thrice as long as the scape, the funicle joints being nodose, pedicellate at apex, the nodose part of the joints with whorls of long hair; the knees of the middle and hind legs are honey-yellow, the front tibiæ, except a brown spot in front near the base, the tips of middle and hind tibiæ and all tarsi, being white. The abdomen is short, oval, highly polished, and attached to the thorax by a petiole which is as long as the hind coxæ.

Type.—Cat. No. 8204, U.S.N.M.

Manila. (Charles S. Banks.) Many specimens.

15. EURYTOMA ALBOTIBIALIS, new species.

Female.—Length 4 mm. Black, the head and thorax closely, umbilicately punctured, clothed with a fine, sparse, white pubescence; the scape, tegulæ, and tips of all the femora are honey-yellow, the tibiæ and tarsi white, the tibiæ toward base faintly tinged with brown, the rest of the antennæ black. The first joint of the flagellum is the longest joint; it is a little more than twice longer than thick, the following joints to the club imperceptibly shortening, the club about one-half longer than the first funicle joint. Wings clear hyaline, the veins pale yellowish, the marginal vein being longer than the post-marginal and thicker; the stigmal vein, with its knob, is about half the length of the marginal. The abdomen is subpetiolate, conic-ovate, subcompressed, pointed at apex, polished black, with the extreme tips of the sheaths of the ovipositor honey-yellow.

Type.—Cat. No. 8215, U.S.N.M.

Manila. (Charles S. Banks.)

Family EULOPHIDÆ.

NESOLYNX, new genus.

This new genus falls into my tribe *Elachertini*, and in my table of the genera^a falls between the genera *Scotolina* Ashmead and *Olynx* Först. The table may be modified to contain it as follows:

11. Mesonotum a little longer than wide.

Abdomen ovate; flagellum not compressed, the joints cylindrical, not or scarcely longer than thick.....*Nesolynx* Ashmead.

Abdomen conic-ovate; flagellum compressed, the joints longer than wide.

Olynx Förster.

16. NESOLYNX FLAVIPES, new species.

Female.—Length 0.8 mm. Black and shining, impunctate, the mesonotum and abdomen with a metallic aeneous tinge in certain lights; scape, pedicel and legs, including the coxæ, pale yellowish, the flagellum brown or brown-black; palpi and tegulæ white. Wings hyaline, the veins brown; the marginal vein is long, about six times as long as the short stigmal vein, which terminates in a small rounded knob; the postmarginal vein is long and slender. The ovate abdomen is as long as the head and thorax united, the basal segment being the longest, the following segments being subequal.

Type.—Cat. No. 8328, U.S.N.M.

Manila. (Father Robert Brown.)

Family ICHNEUMONIDÆ.

Genus CHIODES Förster.

17. CHIODES OCULATUS, new species.

Male.—Length 4.5 mm. Head and thorax black and shining, impunctate, the metathorax long, areolated; the eyes are very large and occupy the whole sides of the head, converging anteriorly, the malar space wholly wanting; the palpi, tegulæ, front coxæ and trochanters, front tibiæ and tarsi, middle and hind trochanters, more or less of the middle tibiæ and tarsi, an annulus at base of hind tibiæ, the ventral segments 1 to 4, inclusive, and the base of dorsal segments 1 and 2, are white; base of dorsal abdominal segments 3 and 4 yellowish; the rest of the legs, except as hereafter noted, brownish-yellow; the hind coxæ have a black spot at base, the second joint of their trochanters, their femora, tibiæ, and tarsi being fuscous or dark reddish-brown. The antennæ, except the first four joints, which are yellow, are black; the first joint of the flagellum is a little longer than the second. The wings are hyaline with the veins, except near the tegulæ, brown, the costal vein blackish.

Type.—Cat. No. 8316, U.S.N.M.

Manila. (Father Robert Brown.) One male specimen.

^a Classification of the Chalcidoidea, p. 354.

Genus MESOSTENUS Gravenhorst.

18. MESOSTENUS LEUCOZONATUS, new species.

Male.—Length 6.5 mm. Black and shiny, impunctate, with the orbits slightly interrupted at apex of eyes, the face below antennæ, the clypeus mandibles, except teeth, palpi, an annulus on the antennæ, tegulæ, a spot beneath, hind margin of prothorax, a large spot on disk of mesopleura, and the large spot on lower hind end, a line on the hind margin of the same, a large triangle spot at base of the insertion of the hind wings, the apical half of the metathorax, the apical margins of all the abdominal segments, the front and middle coxæ and trochanters, the apex of the hind coxæ, basal two joints of front tarsi and the hind tarsi, except base and apex of the first joint, the apex of joints two and three and the following joints, which are black, pure white, the rest of the legs, except the three terminal joints of front tarsi, apex of middle tibiæ, their tarsi, apex of hind femora, apex of hind tibiæ, and all tibial spurs, which are black, being red; the antennæ, except the first four or five joints beneath and the broad white annulus, occupying joints 14 to 16, are black. Wings hyaline, the stigma and veins black, the areolate small, nearly quadrate, receiving the second recurrent nervure a little beyond its middle.

Type.—Cat. No. 8330, U.S.N.M.

Manila. (Father Robert Brown.)

NESOMESOCHORINI, new tribe.

NESOMESOCHORUS, new genus.

This curious new genus is based upon a single female specimen received recently from Father Brown, and its position is uncertain. It is remarkable in several particulars and difficult to classify. In venation and in the petiolated, compressed abdomen it shows some affinity with the tribes *Anomalini* and *Campoplegini*, but it certainly can not belong to either of these tribes, and in my perplexity I have made it the type of a new tribe next to the *Mesochorini*.

The head is transverse, the eyes being abnormally large and occupying the whole sides of the head, converging anteriorly and reaching to the base of the mandibles, there being no malar space; the clypeus is represented by a small convex prominence; the mandibles are small and bidentate at apex; the thorax is about two and a half times as long as thick, narrowed posteriorly, the mesonotum with two sharply defined parapsidal furrows that converge posteriorly; the metathorax is as long as the scutellum, the meso- and pro-notum united, and is distinctly areolated, the basal area being triangular, the areola being long and hexagonal; the abdomen is about twice as long as the head and thorax united, strongly compressed and longly petiolated, and

ends in a prominent ovipositor. The wing venation is similar to that in *Mesochorus*, only the stigma is not so well developed but linear, while the areolet is absent, as in some *Hemitelini*.

19. NESOMESOCHORUS OCULATUS, new species.

Female.—Length about 6 mm.; the ovipositor about one-third the length of the abdomen. Black and shining, impunctate, except the metathorax posteriorly, where the surface is wrinkled transversely; the mesopleura have a long oblique, crenate furrow; the antennæ are ringed with white, the white ring occupying joints 13 to 16, the joints beyond, and the 5 or 6 before, being black; the other joints, except the pedicel, which is white, being brownish or yellowish; the palpi, the tegulæ, front coxæ and trochanters, the first joint of the middle and hind trochanters, and a narrow annulus at base of hind tibiæ are white; the rest of the legs, except the second joint of the hind trochanters, hind femora, and tibiæ, which are dark fuscous, and the basal third or more of the abdominal petiole, are reddish-yellow; the second and third dorsal segments of the abdomen narrowly at the extreme base, and the venter, are whitish; the first and second abdominal segments are very long, about equal in length; the third and fourth segments subequal, united not longer than the second, while the following segments are still shorter. Wings hyaline, iridescent, the costal and internal venis brown.

Type.—Cat. No. 8337, U.S.N.M.

Manila. (Father Robert Brown.) One specimen.

Family BRACONIDÆ.

Genus METEORUS Haliday.

20. METEORUS BROWNII, new species.

Female.—Length 3.5 to 4 mm. Brownish-yellow, with the dorsum and apex of the metathorax, the apex of the abdominal petiole, and the base of the second dorsal abdominal segment black; the palpi and the base of the abdominal petiole are white; eyes brown or purplish brown in certain lights. The metathorax is regulose, while the abdominal petiole is longitudinally striated; wings hyaline, iridescent, the costal vein black, the stigma and internal veins light brownish.

Type.—Cat. No. 8317, U.S.N.M.

Manila. (Father Robert Brown.) Three specimens, all females.

Genus CHELONUS Jurine.

21. CHELONUS ALBICINCTUS, new species.

Male.—Length 2.8 mm. Head, thorax, and abdomen, except the basal two-fifths, which is white, black, the mandibles red with black teeth, the palpi, trochanters, front tibiæ and tarsi, basal two-thirds of

middle tibiae, their tarsi, a very broad band on the hind tibiae, and the hind tarsi, are white; the front femora are more or less reddish, the middle and hind femora, and the base and apex of the hind tibiae, are fuscous black. The wings are hyaline, the internal veins reddish-brown, the stigma piceous. The abdomen is finely regulose with a transverse groove or slit at apex.

Type.—Cat. No. 8318, U.S.N.M.

Manila. (Father Robert Brown.)

Genus PHANEROTOMA Wesmael.

22. PHANEROTOMA ALBISCAPA, new species.

Male.—Length 2.2 mm. Black, the head and thorax finely, closely, punctate; mandibles yellowish; the palpi, the scape and pedicel of the antennae, the tegulae mostly, the ventral membrane, and the legs, except as hereafter noted, are white; the hind femora, except at extreme apex, and the hind tibiae, except a broad annulus at base, are black. The wings are hyaline, but the apical two-thirds of the front wings have a faint smoky tinge; the costal vein, the stigma, the basal vein, and the veins beyond are black or dark brownish-black, while the median and submedian veins are, for the most part, yellowish; the second cubital cell is long triangular and rather narrow.

Type.—Cat. No. 8338, U.S.N.M.

Manila. (Father Robert Brown.)

Genus PSEUDAPANTELES Ashmead.

23. PSEUDAPANTELES AGILIS, new species.

Female.—Length, 1.7 mm.; ovipositor slender, as long as the abdomen. Black and shining, the head and scutellum smooth and shining, impunctate, the thorax, except the scutellum, being finely, minutely punctate; the face has a delicate median carina; the palpi, tegulae, and median veins basally are yellowish-white; the legs, except the front and middle coxae basally, the hind coxae, hind femora, tips of hind tibiae, and hind tarsi, which are black or fuscous black, are yellow or light brownish yellow; the abdomen is smooth and shining, the plate of the first segment being long trapezoidal. Wings hyaline, the costal vein, stigma, and post stigmal veins being brown, the internal veins paler.

Type.—Cat. No. 8339, U.S.N.M.

Manila. (Father Robert Brown.)

Genus *BIOSTERES* Förster.24. *BIOSTERES LONGICAUDATUS*, new species.

Female.—Length, 3.2 mm.; ovipositor longer than the whole insect. Uniformly brownish-yellow, the eyes brown, the antennæ very long, gradually becoming black from the basal fourth, the sheaths of the ovipositor black.

The head and the thorax, except the metanotum, are smooth and impunctate; the parapsidal furrows are deep and converge and meet or unite just in front of the scutellum, the latter with a broad deep furrow at base, which is separated into two by a delicate median carina; the metanotum is areolated and punctulate. Wings hyaline, the stigma and veins brown. The abdomen is a little longer than the head and thorax united; it is smooth and impunctate, except dorsal segments 1 and 2, which are more or less longitudinally striated.

Type.—Cat. No. 8319, U.S.N.M.

Manila. (Father Robert Brown.)

Genus *RHYSSALUS* Haliday.25. *RHYSSALUS UNICOLOR*, new species.

Female.—Length 1.5 mm.; ovipositor shorter than the hind tarsi. Brownish yellow, the sutures of the three-segmented abdomen blackish; stemmaticum black; eyes purplish brown; antennæ toward base (the first five or six joints), the palpi, and the legs white or yellowish white. Wings hyaline, the stigma, except at apex, and the internal veins, except as hereafter noted, yellowish white; the apex of the stigma, the radius, and the costal veins brownish. Head and thorax smooth, the metanotum with a forked carina. The abdomen is longitudinally striated, the segments subopaque.

Type.—Cat. 8320, U.S.N.M.

Manila. (Robert Brown.) One specimen.

Genus *RHOGAS* Nees.26. *RHOGAS MELANOSOMA*, new species.

Male.—Length 4.5 mm. Head and thorax brownish yellow, the ocelli pale and placed on a black spot, the eyes black; the antennæ, except the first two joints, a spot at apex of the middle and hind femora, more or less of the base and apex of the hind tibiæ, the hind tarsi, and the whole dorsum of the abdomen, are black. The abdomen is rugulose, the first, second, and third segments with a median longitudinal carina, that on the third subobsolete. Wings hyaline, the stigma and veins brown.

Type.—Cat. No. 8321, U.S.N.M.

Manila. (Father Brown.)

Genus *BRACON* Fabricius.27. *BRACON VAU*, new species.

Female.—Length 2 mm.; ovipositor about two-thirds the length of the abdomen. Black; the venter, a V-shaped mark on the second dorsal segment of the abdomen, and a median line on the following segments are yellow; the scape of the antennæ, the mandibles—except the teeth, which are black, the palpi, the tegulæ, and the legs entirely, except the hind tarsi, are yellow; the hind tarsi are dark fuscous or black.

The head and thorax are smooth and shining, impunctate, the parapsidal furrows being indicated by depressed lines that converge posteriorly and nearly meet at the base of the scutellum; the dorsum of the abdomen is finely, opaquely sculptured or shagreened.

Wings hyaline; the stigma and the veins, except the median and submedian veins basally, are dark brown; the second cubital cell is rather narrow, only about two-thirds longer than wide at apex, the second transverse cubitus being shorter than the first.

Male.—Length 1.8 mm. Agrees well with the female, except that the antennæ are longer, the legs entirely yellow, the hind tarsi not fuscous, while the median yellow line is absent on the two last segments.

Type.—Cat. No. 8340, U.S.N.M.

Manila. (Father Robert Brown.)

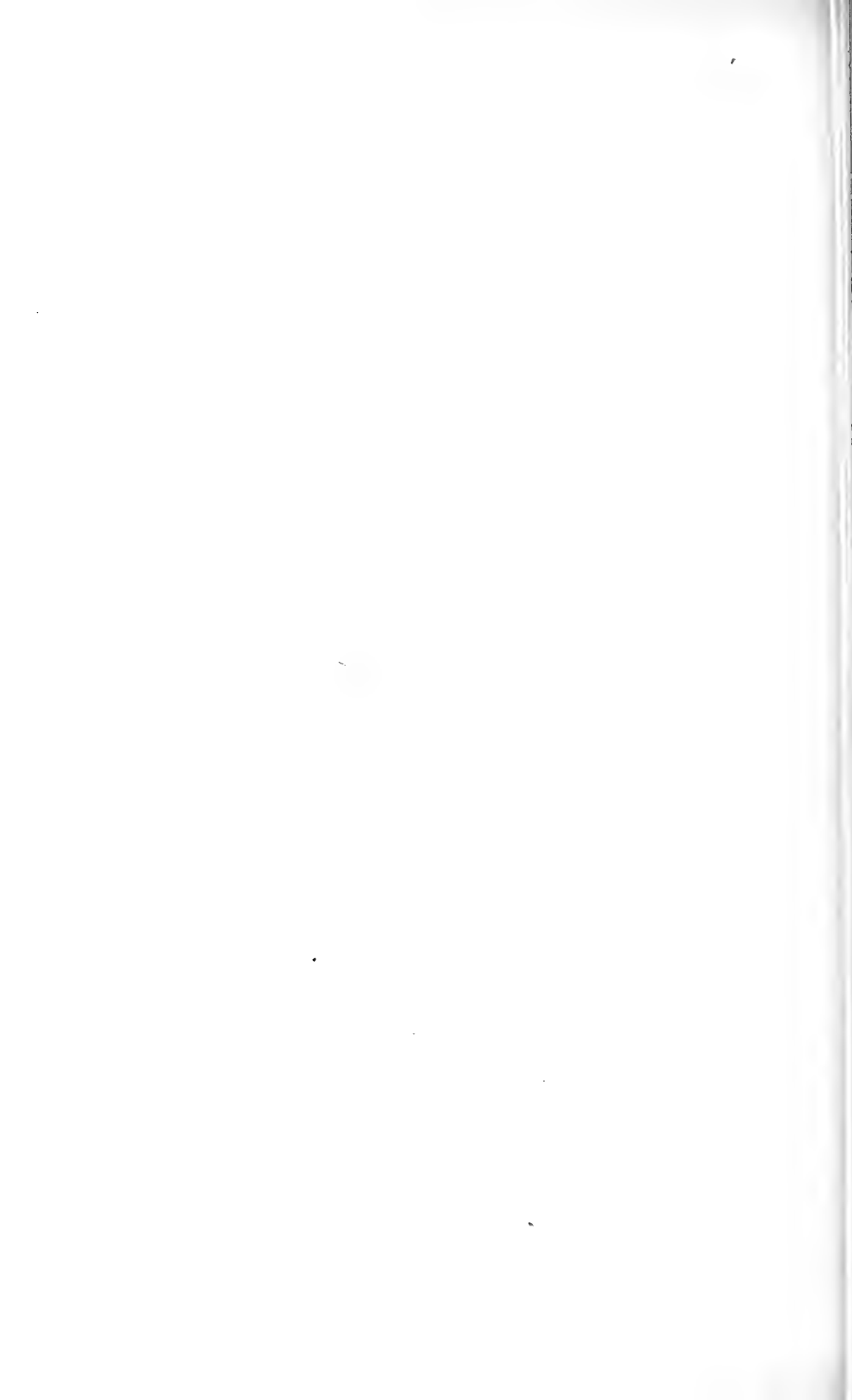
Family *SELANDRIIDÆ*.Genus *PARASELANDRIA* Ashmead.28. *PARASELANDRIA IMITATRIX*, new species.

Male.—Length 3 mm. Black and shining, impunctate, the anterior tibiæ in front and the apex of middle tibiæ yellowish; apices of the joints of middle tarsi are also yellowish; the head has two broad antennal sulci; the third joint of the antennæ is the longest, a little longer than the two preceding joints united or a little longer than the fourth, the following joints shortening. Wings smoky black, the stigma and veins brown black.

Type.—Cat. No. 8322, U.S.N.M.

Manila. (Father Robert Brown.) One specimen.

This is the first sawfly I have seen from the Philippines.



NOTES ON THE FISHES OF PUGET SOUND.

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AND

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The following notes are based on collections made at various localities in Puget Sound during the summer of 1903 by Prof. Trevor Kincaid, of the University of Washington, and Dr. J. C. Thompson, U. S. Navy, and on a further collection made by Professor Kincaid during the summer of 1904. The specimens were secured along shore or by dredging in shallow water. The majority of the species were well-known and are not here listed, but in addition to these the collection contains two undescribed species and six which have not been reported hitherto from Puget Sound. Of the latter, two species have been known only from Alaskan waters, one from the coast of Oregon, two from California, and one from the Gulf of California. That such notable extensions of range can be made on limited collecting indicates that we are still far from an adequate knowledge of the distribution of the fishes of the Pacific coast.

The authors desire to acknowledge their indebtedness to Professor Kincaid for submitting to them this material.

ENTOSPHEMUS TRIDENTATUS (Gairdner).

A male specimen, 350 mm. long, taken in Lake Washington, near Seattle, differs widely from current descriptions of *E. tridentatus*. The differences may be sexual, and the ordinary male form may have been overlooked hitherto. Among the collections of Stanford University is a male specimen from the Rogue River, Oregon, which agrees in almost all details with the Seattle specimen here described. Other specimens before us exhibit the usual conditions and are all females or doubtful as to sex, and the material is too scanty to permit a determination of the question.

The principal differences from the previously recognized form of *tridentatus* are the posterior origin of the first dorsal, the absence of any interval between the two dorsal fins, and the greater height of the fins; there is also a distinct precaudal fold which extends forward to the vent. The head is also longer, the eye larger, and the tail shorter.

The arrangement of the teeth is wholly similar to that in ordinary *tridentatus*. The supra-oral plate contains two large lateral and a small median cusp, the latter distinct, but less than half the length of the lateral cusps. The infra-oral plate is crescentic, with five equally spaced broadly triangular cusps. There are about three series of very small simple teeth on the disk in front of the pre-oral plate, the median tooth larger than the others. Behind the infra-oral lamina are two series, one near the margin, the other halfway between the margin and the infra-oral lamina. The inner series consists of 16 small teeth, each inserted at the inner end of a short radial furrow. The anterior tooth on each side is bicuspid, all the others simple. The lateral portion of the disk contains on each side four larger plates, the anterior and posterior of which are bicuspid, the others tricuspid. The anterior lingual plate has a straight transverse margin, very finely pectinate. The margin of the disk is densely fringed.

The eye is large, its diameter equaling half the interorbital width.

The front of the dorsal is behind the middle of the total length. Its greatest height is two-fifths the length of the fin behind its origin. Posteriorly, it joins the base of the second dorsal, being abruptly notched at point of union. The second dorsal is very high, its longest rays, including muscular area at base, one-fourth the length of the base. A vertical line from the vent traverses the second dorsal at the end of its first fourth. In advance of the lower half of the caudal fin a well-defined rayless fold of the integument extends forward to the vent, increasing in height anteriorly and ending in a rounded lobe.

In spirits, the color is slaty-brown, the posterior part of the first dorsal and the anterior end of the anal fold white. The caudal fin is largely black. The lips and gullet are slaty, the buccal disk whitish.

Measurements in hundredths of total length.

	Lake Washing- ton.	Rogue River.	Klamath River.	Rogue River.	Rogue River.
	<i>Male.</i>	<i>Male.</i>	<i>Female.</i>	<i>Female.</i>	<i>Sex?</i>
Total length (in millimeters)	350	425	263	535	580
Length of snout	8.9	9	8	7.2	7.1
Length of head to first gill slit	14	14.5	11.5	11.4	11
Distance between first and last gill slits	10.8	11	9.5	10.2	10.5
Diameter of eye	2.3	2.3	1.9	1.4	1.5
Length before dorsal	54	51.5	50	49	46.5
Base of first dorsal	16	15.5	14	15	17
Interspace between dorsals	0	0	5.2	5	5
Height of first dorsal	2.6	4.3	-----	2.5	2.3
Base of second dorsal	23.3	26.5	24.5	25	24
Length of caudal from upper notch	6.5	8	7	7	7.2
Distance from vent to tip of tail	25	26	29.3	29.5	29.2

CATULUS BRUNNEUS Gilbert.

A single specimen of this species, known hitherto only from the type which was captured in deep water in the Gulf of California, was taken by Doctor Thompson, at Brinnon, Hood's Canal, Puget Sound. It has been compared directly with the type specimen and found to agree with it closely.

Specimen a female, 42 cm. long.

Body narrow, elongate, compressed, the vent in the middle of the total length. Head slender, with comparatively long pointed snout, strongly resembling the long-snouted species of *Mustelus*. The pre-or al length of the snout slightly exceeds the distance between outer edges of nostrils and equals the interorbital width. The greatest width of the snout slightly exceeds its length before orbits. Anterior nasal valve with a narrowly rounded lobe, the width of which exceeds its length; isthmus between nostrils equaling or slightly exceeding the length of the nostril; labial folds well developed, the upper slightly the longer, the lower one-third or two-fifths the distance from outer labial angle to symphysis.

The teeth bear each a moderate, nearly straight, central cusp, and a pair of small but obvious lateral cusps. Borne on the extreme base of each lateral cusp is a minute denticle, which is usually wholly concealed.

The eyes are small, one-third the width of the mouth between outer labial angles, the small spiracles separated from them by less than one-third their diameter.

The head is very soft and spongy. The snout bears a flask-shaped patch of coarse pores on the middle line above and an elliptical patch below. Other conspicuous patches are one below the front of the eye, one behind the nostril, one behind the spiracle, a pair on interorbital space, and a series running backward and outward from near angle of mouth.

The pectoral is short, with broadly rounded angles; the length of its anterior margin equals its distance from orbit. The base of the anterior dorsal extends a little behind the line of attachment of the ventrals; the anterior fin is smaller than the posterior, the length of its base about three-fifths the distance between dorsals. The length of the anal base is twice that of the second dorsal and extends very slightly behind it. The caudal bears a sharp notch below its terminal lobe, which is about one-sixth its length.

The skin is everywhere covered with minute, closely appressed, triangular scales, each bearing a median cusp and a pair of diverging lateral cusps. All the fins are wholly invested with similar scales. No enlarged plates along back of tail.

Color in spirits: Top of head and a streak along middle of back in front of first dorsal, warm brown; sides of head and body and the fins slate-color; under parts slaty, a light-gray streak extending forward from each ventral base nearly half way to pectorals. All the fins are narrowly black-edged anteriorly. The color may have been uniform brownish in life.

Measurements in hundredths of total length.

	Brinnon, Wash.	Type, Gulf of California.
Greatest depth.....	14.5	14
Length of head, to anterior gill-slit.....	19.5	19
Longitudinal diameter of orbit.....	3	3
Interorbital width.....	8	7.5
Preocular length of snout.....	9.5	9.5
Preoral length of snout.....	8	7.5
Width of head behind spiracles.....	11	11
Greatest width of snout.....	11	10
Width between outer labial angles.....	9.5	9
Length of fold of upper lip.....	3	3.5
Length of fold of lower lip.....	2.5	3
Distance between inner ends of nostrils.....	3.3	3
Distance from snout to pectoral base.....	23	24
Length of anterior margin of pectoral.....	10.5	10.5
Length of interval between pectorals and ventrals.....	18	17
Base of first dorsal, including anterior fold.....	7	6.5
Distance between dorsals.....	8	7.5
Length of base of second dorsal.....	6	6
Length of anal base.....	13	12.5
Length of caudal, measured below.....	30	28
Distance from outer labial angle to symphysis.....	5.5	6
Total length (in millimeters).....	420	485

TARANDICHTHYS FILAMENTOSUS (Gilbert).

A perfectly typical specimen, 98 mm. long, from Hood's Canal. The species was originally described from the Santa Barbara channel, and has been known hitherto only from southern and central California.^a Current descriptions should be corrected in two respects: (1) The interorbital area is comparatively wide, shallowly grooved, the width increasing with age, but the maximum width is only about two-thirds the diameter of the pupil, not, as described, more than half the diameter of the orbit. (2) The two anterior filamentous dorsal spines are produced far beyond the fin-membranes, the latter connecting their basal portions and joining them to the third spine at a level corresponding to the tips of the third and some of the succeeding spines.

ICELINUS BOREALIS Gilbert.

Icelinus strabo STARKS, Proc. Cal. Acad. Sci., 2d ser., VI, 1896, p. 551.

Three specimens, the largest 70 mm. long, were dredged by Professor Kincaid in Griffin Bay, East Sound and West Sound. Reexamination of the types of *I. strabo* show that they are within the range

^a Gilbert, Rept. Comr. Fish and Fisheries for 1893 (1896), p. 469.

of variation of *I. borealis* and belong with that species. The statement introduced by Jordan and Evermann into the key to species of *Icelinus*,^a denying the presence of a nasal tentacle in *I. strabo*, is an error. A simple nasal tentacle is present in the types of *I. strabo*, wholly similar to that found in typical *borealis*.

ASTROLYTES FENESTRALIS (Jordan and Gilbert).

Artedius asperulus STARKS, Proc. Cal. Acad. Sci., 2d ser., VI, 1896, p. 553.

No specimen of this common species was included in the submitted material. It is mentioned here to place on record the fact that the immature types of *Artedius asperulus* are members of this species. In the young of *Astrolytes*, the lowermost of the three prongs of the preopercular spine is still undeveloped at a time when the upper two prongs are strong and equally developed. The third or lower prong makes its appearance first as a small, flattened prominence on the lower side of the middle prong near its base. We find it undeveloped on one side, but evident on the other, in a specimen of *A. fenestralis* nearly twice the size of the types of *A. asperulus*. In one of the latter it is apparent on one side, though minute. In all the types, the occiput is partly covered with spinous plates and bears a number of filaments. We have compared the types directly with *A. fenestralis* and find them to agree in all respects.

The genus *Axyrius* Starks^b is scarcely distinct from *Astrolytes*, with which it agrees in all characters except the slenderness of the preopercular spine. In the type of *Axyrius harringtoni*, a short prominence is found on the lower side of the lower prong, agreeing in position with the third prong in *Astrolytes fenestralis*.

STELGIDONOTUS, new genus (Cottidæ).

Allied to *Rastrinus*; differing in the cuboid head, with its wide inter-orbital space, vertical cheeks, blunt snout, and broad U-shaped subinferior mouth, in the absence of plates or spines on the head, and in the simple, strong, falcate preopercular spine.

Type.—*Stelgidonotus latifrons*, new species.

STELGIDONOTUS LATIFRONS, new species.

Type 24 mm. long, from Friday Harbor, Washington, collected by Prof. Trevor Kincaid. Cat. No. 53027, U.S.N.M.

Dorsal IX, 19; anal 15; pectoral 13; ventral I. 3; tubes in lateral line 39.

Body slender, terete, tapering to the very slender caudal peduncle. Head with vertical cheeks, its height and width equal. Occiput gently

^aFishes of North and Middle America, p. 1894.

^bProc. Cal. Acad. Sci., 2d ser., VI, 1896, p. 554.

convex transversely; the broad interorbital space with a shallow lengthwise groove. Snout short and bluntly rounded, its sides vertical. Nasal spines strong. Width of preorbital 2.1 times in orbit. Mouth horizontal, broadly U-shaped, at lower side of snout, the mandible included. Maxillary reaching vertical from middle of orbit. Well-developed bands of teeth in jaws and on vomer and palatines. Top of head smooth, without plates, ridges, spines, or dermal flaps. Upper preopercular spine simple, strong, falcate, its length two-thirds the diameter of the eye; three blunt prominences below it. Opercle with a strong horizontal rib, but without spine. Eyes circular, without vertical range. Gill membranes united across throat, forming a wide, free fold. No slit or pore behind fourth gill arch. Head with series of very large mucous pores.

Back and sides thickly invested with small plates, each bearing a depressed spine. The spinous area includes the nape, and the back and sides of the caudal peduncle. A narrow strip along base of anal is naked, as are also the lower side of caudal peduncle, the entire head,

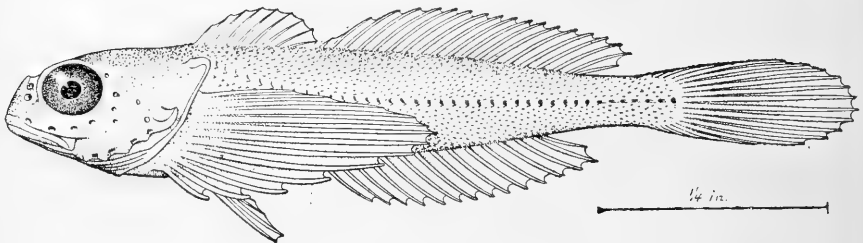


FIG. 1.—*STELGIDONOTUS LATIFRONS*.

breast, and abdomen, and the postaxial area. There are no enlarged plates or spines. The plates of the lateral line are very thin and inconspicuous; each pore is armed with a pair of minute diverging prickles.

Anterior dorsal low, continuous, gently rounded, of slender spines, wholly distinct from the second dorsal. Anal similar to second dorsal, beginning slightly in advance of dorsal and ending well in advance of last dorsal ray. Vent immediately in front of first anal ray. Pectorals very long and slender, the middle rays longest, reaching base of sixth or seventh ray of second dorsal. Ventrals reaching vent.

In spirits light gray, the upper parts coarsely punctate with black. Faint dark bars cross the back, two under spinous dorsal, three under soft dorsal, one on back of caudal peduncle. On the posterior half of sides, just below the lateral line, a series of small, round light spots are surrounded by incursions of the darker color of the back. Fins translucent. According to Professor Kincaid, the specimen was bright green in life.

Measurements in hundredths of length to base of caudal.

Length of head.....	32
Width of head.....	20
Interocular width.....	10
Length of snout.....	8
Width of snout.....	10
Diameter of eye.....	10
Length of maxillary.....	13
Width of mouth.....	12
Tip of snout to first dorsal spine.....	30
First dorsal spine to front of second dorsal.....	23
Base of second dorsal.....	37
Base of anal.....	35
Length of pectoral.....	38
Length of ventral.....	18
Length of caudal.....	25
Length of caudal peduncle from last anal ray.....	12
Length to base of caudal (in millimeters).....	19

MALACOCOTTUS KINCAIDI, new species.

Type 67 mm. long, from Brinnon, Hood's Canal, Washington; collected by Prof. Trevor Kincaid. Cat. No. 53028, U.S.N.M.



FIG. 2.—*MALACOCOTTUS KINCAIDI*.

Similar to *Malacocottus zonurus*, differing in the less robust form, the shorter head, the reduction or obsolescence of the cirri on the head, and the absence of the accessory spine which in *M. zonurus* projects laterally at right angles to the cheek, from the base of the middle preopercular spine. In structure of fins and in color the two species are very similar.

Dorsals IX-14; anal 11, the last ray divided to the base; ventral 1, 3; pectoral 21.

Length of head 40 hundredths of total length to base of caudal; eye 13; interorbital width 5.5; length of snout 11; maxillary 18; depth of body 27; depth of caudal peduncle 7; length of caudal peduncle 17; length of pectoral 29; length of caudal 27; length of ventrals 14; length of longest soft dorsal ray 22.

Head large, with nearly vertical cheeks, and a gently arched upper profile. The mouth is somewhat oblique, the maxillary extending nearly to the vertical from the posterior margin of the pupil. A pair of low occipital protuberances are present, less developed than in *M. zonurus*. The interorbital space is gently concave; it bears posteriorly a pair of ridges which join the supraorbital rim anteriorly, and converge toward the occiput but do not meet. No nasal spines are present. The posterior margin of the anterior nostril bears a short flap. The preopercle bears two slender diverging spines at the angle, the lower without trace of the accessory spinelet so conspicuous in *M. zonurus*; below and in front of the two diverging spines is a third directed downwards and forwards. The opercle is marked with two strong ribs, the upper of which is broad and longitudinally striate, but the ribs do not terminate in spines.

The jaws contain narrow bands of villiform teeth; the vomer and palatines are toothless. The gill membranes are broadly attached to the throat, and have the posterior margin wholly adnate. The appendages to the branchial arches are tubercular and spinous, similar on all the arches, those on the anterior limb nine in number. The fourth arch bears but a single row of filaments, and is without posterior pore or slit. A free fold of membrane, with marginal papillae, is attached to the inner face of the ceratohyal, and serves obviously as a valve to close the cleft in front of the first gill arch. The pseudobranchiae are large.

The dorsal fins are contiguous, the anterior low, with weak flexible spines. The second dorsal is longer than the anal, overpassing it both anteriorly and posteriorly. The pectorals have a broad procurrent base, the lower rays rapidly shortened. The ventrals are short, their length about equaling the diameter of the orbit, their basal half included within the integument of the abdomen.

Series of large mucous pores on the top and sides of the head; those along the course of the lateral line 15 in number.

Two pairs of blackish cross-blotches on the lips, the anterior much the larger. Head inconspicuously blotched and spotted with dusky. Three irregular dark cross-bars on the back, one under spinous dorsal, a broad well-marked bar below second dorsal, and a narrower one on the caudal peduncle and the basal portion of the caudal fin. The bars are more or less broken up by streaks or mottlings of the lighter brown color. The abdomen has a bluish or purplish tinge, and is punctate with black. The pectorals are dusky on the basal third, sometimes mottled, a light bar sometimes occupying the middle third of all except the lower rays; the terminal third is blackish, all except a few of the uppermost rays with whitish tips. The ventrals are dusky with whitish tips. The spinous dorsal is blackish, the soft dorsal with three or four oblique blackish bars, the anterior bar usually much wider than the

others. The anal is obscurely marked with oblique narrow cross-bars. The basal dark bar of the caudal is continued backwards on the upper and the lower rays, and serves partly to inclose the broad white bar which follows. The distal half of the fin is marked with one or two dark bars, and has a narrow white margin.

Numerous specimens have been examined. The species is evidently abundant in Puget Sound, where it is easily dredged in shallow water. The species is named for Prof. Trevor Kincaid, who is so energetically increasing our knowledge of the zoology of Puget Sound.

GILBERTIDIA SIGOLUTES (Jordan and Starks).

A second specimen of this interesting species, 68 mm. long, was dredged by Professor Kincaid in East Sound, in August, 1904. We have compared it directly with the diminutive type of the species without discovering important differences. The mouth seems less oblique and the mandible less prominent, but this may be due to a slight distortion in the type. We have examined it in connection also with specimens of *Psychrolutes paradoxus*, with a view to determining the value of the characters alleged to separate *Gilbertidia* and *Psychrolutes*. The distinctive characters of *Gilbertidia*^a are said to be: (1) the very long continuous dorsal and anal fins; (2) the condition of the anterior rays of the dorsal, which are not concealed beneath the integument of the back; (3) the form of the mouth. *Psychrolutes* was originally described as having no spinous dorsal, but Jordan and Evermann say that the spinous dorsal consists of "short, slender, flexible spines, entirely embedded in the skin and not visible without dissection, as the spines do not rise above the level of the muscles." Again they say: "Dorsals united, with a slight notch between, the first buried in a ridge of skin so that its delicate spines can not be counted from without." Reexamination of *Psychrolutes* has shown that the above statements do not adequately represent the facts. There is usually no external trace of the spinous dorsal, the thick skin passing smoothly over the middorsal line without fold or attachment. On removing the integument, the spinous dorsal is found to consist of well-developed slender spines, lying loosely in the subcutaneous tissue, and joined together by membrane in the usual manner. They are movably articulated at the base, and are not at all embedded in the muscular tissue. They slightly increase in length posteriorly, and join the soft dorsal without notch. The spines are 10 to 12 in number, the soft rays 12 to 14; the first spine is inserted over the opercular flap.

It is evident therefore that in length and shape the dorsal fin in *Psychrolutes* does not differ from that in *Gilbertidia*, the only differ-

^a *Gilbertina* (preoccupied) Jordan and Starks, Proc. Cal. Acad. Sci., (2), V, 1895, pp. 811, 812. Jordan and Evermann, Fishes of North and Middle America, Pt. 2, p. 2027.

ence of importance consisting in the concealment of the spinous dorsal in *Psychrolutes*. A minor difference is found in the backward extension of the vertical fins in *Gilbertidia*, the dorsal and anal being separated from the caudal only by a notch, leaving none of the caudal peduncle free. Because of the condition of the type of *G. sigolutes*, this character could not be determined and is incorrectly represented in the figure of the type. In the larger specimen before us, the upper profile of the anterior part of the head is less concave than is represented in the type drawing, the snout is more bluntly rounded, the mouth is less oblique, and the maxillary scarcely extends beyond the vertical from the middle of the eye. The shape of the head does not differ essentially from that of *Psychrolutes paradoxus*. In *Gilbertidia*, however, the fold of the lower jaw is continuous across the symphyseal region, while in *Psychrolutes* it is broadly interrupted in the middle line by a frenum. The spine described on the anterior end of the preorbital and that on the upper part of the shoulder girdle are not externally apparent in this larger example. The fin rays and proportions are as follows:

Dorsal VIII, 16; anal, 13; pectoral, 16.

Total length.....	millimeters..	68
Length to base of caudal.....	do.....	56
Length of head.....	hundredths..	39
Greatest depth.....	do.....	26
Depth of caudal peduncle.....	do.....	7
Greatest width of head.....	do.....	28
Length of snout.....	do.....	12
Diameter of eye.....	do.....	7
Interocular width.....	do.....	14
Length of maxillary.....	do.....	17
Snout to first dorsal spine.....	do.....	37
Length of pectoral.....	do.....	35
Length of ventrals.....	do.....	17
Length of caudal.....	do.....	23

XENERETMUS INFRASPINATUS Gilbert.

One specimen of this well-marked species, 98 mm. long, was dredged by Professor Kincaid in East Sound, July, 1904. The only specimens hitherto known were the type and cotype taken by the U. S. Bureau of Fisheries steamer *Albatross* off Cape Flattery at a depth of 77 fathoms.^a The specimen here listed agrees with the type in fin-formulae and measurements and in all the distinctive characters of the species. The following corrections should be made in the original description, and apply as well to the type as to this specimen. The least interorbital width equals three-fourths the diameter of the orbit. The rostral plate contains six instead of five spines, as follows: three short spines on its upper surface, directed upwards and backwards; one

^a Gilbert, Proc. Cal. Acad. Sci., 3d ser., III, 1904, p. 262, pl. xxvii.

strong spine at each outer angle, directed outwards and backwards; one very small spine between the two last mentioned, directed forwards from the median line. This median spine is not found in any other known species. There are faint, darker (not lighter) bars on back and sides.

Still a fourth specimen, a female, is in the collection of Stanford University, taken by the U. S. Bureau of Fisheries steamer *Albatross* at station 3259, in Bering Sea, depth 41 fathoms. The head and body are very much wider than in the specimens noted above, which are all males. The spines are shorter and blunter, the eye smaller, the ventrals shorter, and the lower pectoral rays are not produced beyond the outline of the fin. These are all sexual characters, parallel differences being found between the sexes in other species. The fin-rays are dorsal V-5, anal 8.

LIPARIS DENNYI Jordan and Starks.

Numerous specimens were dredged by Professor Kincaid in East Sound, Friday Harbor, and Upright Channel, Washington, in July and August, 1904.

The species is very close to *L. fucensis*, agreeing in size of disk and in the very wide gill-cleft. *L. dennyi* is more robust in form, with longer dorsal and anal fins, and these more extensively connate with the caudal fin. The two species form an evident transition to *Neoliparis*. In *L. dennyi* the first five to seven dorsal rays are unjointed, slender, and spine-like, but they usually increase in length regularly from the first and can not be distinguished from the articulated rays except by dissection. In the adult type of the species, the first twelve rays are unjointed, indicating apparently that this condition invades the fin with increasing age. Both dorsal and anal join the caudal for almost the entire height of the fins, with little or no notch, the basal third or two-fifths of the caudal being thus adnate with the anal. The dorsal contains in all 38 to 40 rays.

In *L. fucensis* the first five dorsal rays are slender and unjointed. They sometimes pass imperceptibly into the rayed portion of the fin, but more often form an anterior lower lobe, separated by a shallow notch from the rest of the fin, the middle spines a little higher than the anterior and posterior. Both dorsal and anal terminate in rounded posterior lobes, and are either wholly free from the caudal or join the latter only at its extreme base. The dorsal contains in all 35 or 36 rays. *Neoliparis fissuratus* Starks^a is a synonym of *L. fucensis*. The genus *Neoliparis* apparently should be withdrawn.

In the type of *L. dennyi*, the diameter of the disk is contained $1\frac{1}{2}$ times in its distance from tip of mandible, $1\frac{1}{2}$ times in its distance from front of anal. The vent is very slightly nearer the front of the

^aProc. Cal. Acad. Sci., 2d ser., VI, 1896, p. 560.

anal than the posterior margin of the disk. In younger individuals the vent is more posteriorly placed, its distance from front of anal varying from one-third to two-thirds the distance to edge of disk, according to the size of the specimen. The teeth seem to be uniformly in 13 or 14 series in each half of either jaw.

Four different types of coloration are found among the new material: (1) Nearly plain brown with obscure dusky mottlings, the pectoral finely cross-barred with black and white. (2) The entire upper parts, including the dorsal fin, marked with parallel wavy light streaks with darker margins, the intervals between the streaks dusky olive; pectoral more obscurely barred. (3) Entire upper parts dark olive, thickly covered with small, white spots less than the diameter of the pupil. (4) Lighter olive, marked with few whitish or silvery white narrow streaks or bars, which are black margined. One series of these cross the dorsal fin, another the anal, both continued a variable distance on the body. Other streaks or spots occupy the top and sides of the head and may be symmetrically disposed on the two sides of the same individual, although not agreeing in different specimens. An approach to this type is found in one specimen in which the brown of the sides is divided by coarsely reticulating light lines, some of which run out on the bases of the fins.

PLECTOBRANCHUS EVIDES Gilbert.

The present collection contains a fine specimen of this species, 129 mm. long, from Hood's Canal; the second to be placed on record. The type was dredged by the U. S. Bureau of Fisheries steamer *Albatross* in shallow water off the coast of Oregon.

The pair of canines in the front of the premaxillaries are less marked than the type description would indicate, being evident, but not much larger than the remaining teeth of the outer series. The mandibular teeth form anteriorly a moderate band which tapers behind, but is not reduced to a single (irregular) series much in advance of the corner of the mouth. No anterior canines are visible on the mandible in this specimen.

No pores are evident in the lateral line, but its course is indicated by a series of widely spaced whitish bodies, much less numerous than the scales.

The nostril opens in a short tube with thin walls, collapsing in preserved specimens, and resembling then a simple flap.

The dorsal contains 55 spines; the anal 2 spines and 35 rays; the pectoral 15 rays.

Measurements in hundredths of length, without caudal.

Length of head.....	21
Length of snout.....	5
Diameter of eye.....	5.5

Length of maxillary	7
Depth of body	11
Depth of caudal peduncle.....	4.5
Distance from snout to dorsal	17
Length of longest dorsal spine.....	5
Distance from snout to anal.....	48
Length of second anal spine.....	3
Length of caudal.....	11.5
Length of longest pectoral ray.....	12.5
Length of ventral.....	8

Plectobranchus is most nearly allied to *Leptoclinus*, agreeing with the latter in the nonprotractile premaxillaries, the development of a pair of anterior canines in each jaw, and the elongation of the lower

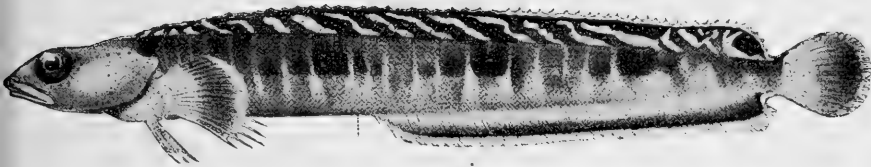


FIG. 3.—PLECTOBRANCHUS EVIDES.

pectoral rays. *Poroclinus* also has the upper jaw nonprotractile, while in *Leptoblennius* and *Lumpenus* a post-labial fold is well developed.

BROSMOPHYCIS MARGINATUS (Ayes).

A specimen 177 mm. long, from Puget Sound, gives a notable extension of the range of this rare species, known hitherto only from the vicinity of San Francisco.

The dorsal contains 108 rays, the anal 75. In a specimen from San Francisco, described by Jordan and Evermann,^a the fin rays have been incorrectly enumerated, and should stand: Dorsal 100, anal 76.

Measurements in hundredths of length, without caudal.

Length of head	25
Diameter of eye	4
Interorbital width.....	4.5
Length of snout.....	6
Length of maxillary	11.5
Width of head	12.5
Greatest depth, at front of dorsal	20
Depth at base of caudal	2.5
Distance from snout to dorsal.....	33
Distance from snout to ventrals.....	19
Distance from snout to anal.....	50
Length of ventrals.....	14
Length of pectorals.....	16

^a Fishes of North America, Pt. 3, p. 2502.

The last anal ray is partly united with the basal portion of the caudal in this young northern specimen—a character we can not verify in southern adults. The species has 7 branchiostegals and the lateral line is evident, forming a strong arch anteriorly above the pectorals.

LYCODES BREVIPES Bean.

A single specimen, 192 mm. long, was taken by Professor Kincaid in East Sound, Puget Sound. The species has been known previously only from Alaskan waters. The fin rays have been incorrectly enumerated in this species. Counting to the middle of the tail, we find in four specimens, including the Puget Sound example, the dorsal contains 98 to 102 rays and the anal 82 to 89. The differences between *L. brevipes* and *L. palearis* are small in amount, but seem to be constant. The suggestion having been made that they were due to sex, we have examined that matter in 9 specimens of *L. brevipes*, with the result that 5 were found to be females and 4 males. We give below measurements of the Puget Sound specimen in hundredths of the total length:

Length of head.....	22
Length of snout.....	7.5
Diameter of eye.....	5
Length of maxillary.....	9
Distance to front of dorsal.....	29.5
Distance to vent.....	43
Depth of body.....	12
Length of pectoral.....	12
Length of ventral.....	2

LYCONNECTES ALEUTENSIS Gilbert.

Lyconectes aleutensis GILBERT, Rept. U. S. Fish Comr. for 1893 (1896), p. 452, pl. xxxiv.

Two fine specimens, 205 and 238 mm. long, were taken at Brinnon, Hood's Canal, Puget Sound. The species has been known hitherto only from the type specimen, taken by the U. S. Bureau of Fisheries steamer *Albatross* in 1890, north of Unalaska Island, at a depth of 45 fathoms.

In the specimens before us, the dorsal contains 67 spines, the anal 46 and 49 rays, the pectorals 13 rays, the caudal 17 and 18 rays. The first two anal rays are spine-like, being simple, stiff, and pungent, but they are distinctly articulated. The remaining anal rays are all soft, and are once cleft near their tips, the branches thus formed being closely joined throughout except in the posterior rays, where they diverge.

The eyes completely fill the sockets, their sunken condition in the type having been obviously the result of the strong spirits employed in its preservation. There is a deep circular pit, with diameter about

equaling the diameter of the pupil, on the median line of the snout immediately behind the tips of the short premaxillary spines. There are but three strong conical teeth on the head of the vomer in one specimen, four in the other; the palatines are toothless. The smaller specimen contains two slender filaments on the margin of the interopercle, and one at the lower edge of the cheek. These are not evident on the larger example.

The lateral line could not be distinguished in the type, doubtless owing to the shriveled condition of the skin. It consists of a series of small distant papillæ, each perforated with a central pore. They are irregularly spaced, long and short intervals frequently alternating, giving thus the appearance of a paired arrangement. Six or seven of them form a crowded series on the basal fourth of the caudal fin.

Measurements in hundredths of length, without caudal.

Length of head	16	15.5
Greatest depth	7.5	8
Length of snout	3.5	4
Diameter of eye	1	1
Interorbital width	3	2.5
Length of maxillary	5	5.5
Width of head	8	8.5
Distance from snout to dorsal	16	16
Distance from snout to anal	44	45
Length of pectoral	3.5	4
Length of caudal	9.5	9.5



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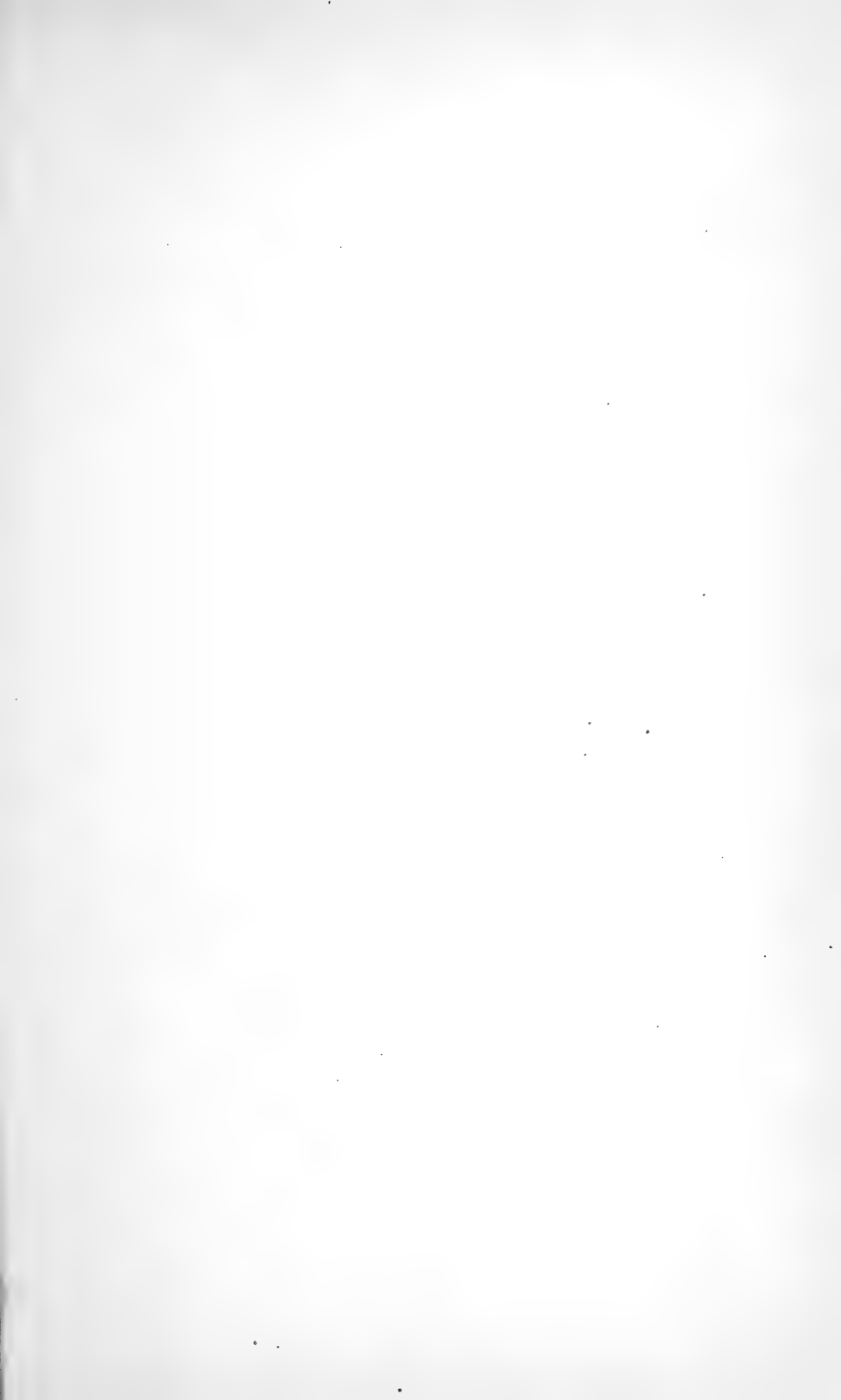
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